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L8	l1 near (problem or flow or congestion or accident or jam)	14953	L8
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L5	L4 near l3	18508	L5
L4	route or path or segment or road	2085373	L4
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L14: Entry 28 of 56 File: USPT Nov 19, 2002

DOCUMENT-IDENTIFIER: US 6484092 B2
TITLE: Method and system for dynamic and interactive route finding

Abstract Text (1):
A method and system for dynamic and interactive navigation is presented. A navigation request is received from a user. The navigation request comprises an originating location description, a destination location description, and at least one criterion to be satisfied by a desired route. Dynamic condition information associated with at least one route between the originating location and the destination location is retrieved. Based on the dynamic condition information, a desired route between the originating location and the destination location is determined.

Brief Summary Text (3):
The present invention relates in general to navigation. Specifically, the present invention relates to methods and systems for dynamic and interactive navigation.

Brief Summary Text (5):
Route finding methods or navigation methods are used to identify one or more routes between a specified originating location and a destination location. The identified routes are often determined based on certain user-specified criteria, such as shortest or fastest travel time. Evaluation of a route with respect to specified criteria is usually performed using recorded road information, such as length of road and road speed limit. Such information is static and does not incorporate the dynamics of the road. Examples of such dynamics include traffic congestion, road construction, or snow conditions. Dynamic information may significantly affect route evaluation.

Brief Summary Text (6):
Route finding methods that rely on static information may not accurately estimate travel time between an originating location and a destination location. In addition, the exclusive use of static information may preclude a route finding method from flexibly altering a route during travel. For example, if a user takes a route recommended by a navigation method based on a "fastest" route criterion, the user has no recourse if traffic on the route is at a standstill. If the user requests a new route based on the same criterion, the navigation method may recommend the same route because the method has no access to dynamic information, such as traffic information, that may trigger an unsatisfactory evaluation of the earlier-recommended route.

Brief Summary Text (7):
Therefore, what is needed is a navigation method and system that incorporates various kinds of dynamic information in determining a route.

Drawing Description Text (2):
FIG. 1 is a high-level block diagram of a navigation system according to an embodiment of the present invention.

Drawing Description Text (3):
FIG. 2 is a high-level block diagram of a navigation system according to an embodiment of the present invention.

Detailed Description Text (5):
A method and system for dynamic and interactive navigation, as described herein, involves receiving a navigation request from a user. The navigation request may

comprise an originating location description, a destination location description, and at least one criterion to be satisfied by a desired route. Dynamic condition information associated with at least one route between the originating location and the destination location is retrieved. Based on the dynamic condition information, a desired route from the originating location to the destination location is determined.

Detailed Description Text (6):
FIG. 1 illustrates navigation system 100 according to an embodiment of the present invention. System 100 comprises input mechanism 120, receiver 130, route calculator 140, output mechanism 150, and database 155. Database 155 includes dynamic condition information 160. Various components of system 100 may be integrated into, or coupled with, a navigational device, such as a handheld subscriber unit or a unit configured to be mounted in a vehicle, such as a car, truck, bicycle, motorcycle, golfcart, or wheelchair. System 100 may communicate with other local or remote devices via wireless means or wire-based means. As such, system 100 may include an antenna 135.

Detailed Description Text (7):
Input mechanism 120 receives a navigation request 110 from a user 105. Navigation request 110 may include an originating location description, a destination location description, and at least one criterion to be satisfied by a desired route. Location descriptions may comprise, for example, a street address, a location relative to a landmark, a location in coordinates, or an alias previously associated with the location by user 105. A criterion may specify one or more attributes of a desired route or routes. For instance, a criterion may include "short, "shortest," "fast," "fastest," "least expensive," "safest," "most picturesque," and "energy efficient."

Detailed Description Text (8):
Input mechanism 120 may comprise, for example, a speech processing input mechanism, a keypad, a keyboard, or a mouse. Receiver 130 receives navigation request 110 from input mechanism 120. Receiver 130 may retrieve, from database 155, dynamic condition information 160 associated with at least one route between an originating location and a destination location.

Detailed Description Text (12):
Dynamic condition information 160 may also include user-specific information, such as preferences of user 105. User preferences may be initialized based on preferences stored on a medium, and may be updated during navigation. Such user preferences may include information concerning risk. Specifically, user 105 may prefer to not risk traversing a route that has one or more predetermined characteristics. For instance, if snow is predicted or reported along a candidate route, user 105 may not wish to traverse that route. As such, user 105 may not be presented with that route. Alternatively, user 105 may be presented with potentially hazardous routes, and may decide whether to select or reject the routes. Risk factors may be applied after a candidate set of routes is determined in view of other dynamic condition information.

Detailed Description Text (13):
User preferences may further include a probability, or measure of confidence, that a desired route has a characteristic desired by user 105. If user 105 seeks the "fastest" routes, and user preferences specify a probability of 90%, then only candidate routes that are at least 90% likely to be the "fastest" route may be presented to user 105 by output mechanism 150. User preferences may be stored on a medium or dynamically received by system 100 during navigation.

Detailed Description Text (14):
Route calculator 140 receives dynamic condition information 160 and navigation request 110 as inputs. Based on dynamic condition information 160, route calculator 140 may determine a desired route or routes 170 between an originating location and a destination location specified in navigation request 110. User 105 may select a desired route from among the set of candidate routes. In an exemplary implementation, the retrieval of dynamic condition information 160 and determination of a desired route 170 are iterated until the destination location is reached, as detected by route calculator 140 or another such processor. As such, user 105 may be rerouted as user 105 navigates toward a final destination location.

Detailed Description Text (15):
Pursuant to well known methodologies in the art, route calculator 140 may incorporate algorithms that assign cost factors or weights to various parameters, such as dynamic condition information parameters. Multiplication of cost factors and the parameters, and summation of the resulting products, may generate numeric values, or "costs," for each route. These costs may then be compared. Such algorithms may be probabilistic in nature. For instance, if one hour is estimated to reach a destination, the travel time may be associated with a probability of 0.9, or 90 percent. Of course, route calculator 140 may employ other algorithms, including algorithms within a neural network. As such, cost factors or weights may be updated with experience. For instance, user actual times versus predicted times on similar roads under similar conditions, as well as how various conditions affect actual time versus predicted time, may be considered by route calculator 140.

Detailed Description Text (16):
Route calculator 140 may also retrieve parameters from a user database. Such a user database, which may be contained in database 155 or another database, may include information that reflects historical behavior of various users of navigation system 100. For example, if both a husband and wife utilize navigation system 100, the user database may reflect the fact that one or both spouses typically engage cruise control and that one spouse drives faster than the other spouse on highways. Route calculator 140 may incorporate such parameters in order to more accurately determine costs of routes.

Detailed Description Text (17):
Additionally, route calculator 140 may determine that dynamic condition information 160 necessitates intervention by user 105. Dynamic condition information may be presented to user 105 via output mechanism 150. Via input mechanism 120, user 105 may then specify a navigation change request.

Detailed Description Text (18):
For instance, user 105 may be informed that, "there is a traffic jam ahead that is predicted to be cleared in one hour. Your estimated time to hit the traffic jam is 45 minutes. Do you wish to consider alternate routes?". Similarly, user 105 may be informed that, "there is a problem which will necessitate an estimated delay of two hours if you go via the second intermediate destination. Rerouting and missing the second intermediate destination will save you an estimated hour-and-a-half. Do you still wish to go via the second intermediate destination?"

Detailed Description Text (19):
Desired route 170 or other informational output 180 may be conveyed to user 105 via output mechanism 150. Output mechanism 150 may comprise, for example, a speech synthesis output mechanism, an LCD display, a Braille output device, or a printer. Other informational output 180 may comprise status messages relating to dynamic condition information 160, such as estimated arrival time, or messages requesting user 105 to take action, such as to input a new navigation request 110 into input mechanism 120.

Detailed Description Text (20):
FIG. 2 is a high-level block diagram of navigation system 200 according to another embodiment of the present invention. System 200 comprises input mechanism 120, receiver 130, navigation request generator 220, route calculator 140, output mechanism 150, and database 155.

Detailed Description Text (21):
Input mechanism 120, receiver 130, route calculator 140, output mechanism 150, and database 155 are described above. In addition, input mechanism 120 may receive a query 210 provided by user 105. Query 210 may comprise a location, such as a desired destination location. The location may comprise one or more particular locations or generic locations. Receiver 130 receives query 210 and retrieves dynamic condition information 160 based on query 210. For instance, query 210 may comprise the genus "art museum." Receiver 130 may retrieve dynamic condition information 160 that includes locations of particular art museums, such as particular art museums within a predetermined distance of user 105, or within a predetermined distance of a route user 105 is presently traversing. Locations specified in query 210 may also relate to

nearby tourist attractions.

Detailed Description Text (22):
Query 210 may also include a query criterion. Such a criterion may further define the location or locations specified in query 210. For instance, a query criterion may include the cost to patronize an establishment. Therefore, if a query specifies "restaurant" and "cost to patronize," navigation request generator 220 may determine routes to restaurants and associated dining costs. Additional criteria may include time to reach the restaurant, distance to reach the restaurant, and name or type of restaurant. Thus, user 105 may query for Chinese restaurants located within an hour of the present position of user 105 and situated along the present route or another suitable route. If multiple restaurants are found by navigation request generator 220, then the relative costs may be calculated and compared to enable user 105 to make a more informed decision as to which restaurant to patronize. Via a connection to another information database (not shown), navigation request generator 220 may also cross-reference the returned restaurant options with telephone book entries. Thus, user 105 may call desired restaurants from a cellular phone to ascertain the ability of the restaurant to accommodate user 105 and the requisite number of guests.

Detailed Description Text (23):
Based on dynamic condition information 160, navigation request generator 220 may determine zero or more destination locations that satisfy query 210. User 105 may then select a particular destination location from among the destination locations determined by navigation request generator 220. Accordingly, navigation request generator 220 may then generate an updated navigation request based on the selected destination location. Thus, navigation request generator 220 may perform rerouting functions, including those described above.

Detailed Description Text (24):
For example, navigation request generator 220 may determine respective destination locations for three art museums. Interactively, user 105 may select from among these locations. Navigation request generator 220 may then forward a navigation request to route calculator 140 that includes the chosen destination location. Route calculator 140 may determine route 230 such that user 105 may navigate to the chosen art museum.

Detailed Description Text (25):
FIG. 3 is a high-level flow diagram illustrating method 300 according to the present invention. A current position 301, a destination 310, and map data 320 are inputs to process 305. Current position 301 may comprise geographic coordinates of a user, such as those provided by a Global Positioning Satellite (GPS) receiver. Alternatively, current position 301 may be supplied by a user via an input mechanism or by a navigation device that accesses a look-up table. Destination 310 may be supplied by a user via an input mechanism, or may be extracted from a database of locations. Map data 320 may comprise map information stored locally on a medium or retrieved from a remote server or service provider. It is to be appreciated that map data 320, though represented in FIG. 3 as stored data, may comprise data that is generated and transmitted directly to a processor of a navigation system.

Detailed Description Text (26):
Based on current position 301, destination 310, and map data 320, process P305 determines a set of candidate routes 315. Each candidate route 315 may begin at current position 301 and end at destination 310, and may comprise directions to enable user 105 to traverse a route from current position 301 to destination 310.

Detailed Description Text (29):
FIG. 4 is a flow diagram illustrating another embodiment of the present invention. As shown, user preferences 401, current position 301, destination 310, and map data 320 are inputted to process P410. User preferences 401 may comprise preferences as to points of interest about which a user seeks information. For instance, user preferences may include the list "museum," "park," "national monument," "waterfall," "outlet mall," "hospital," and "service station." User preferences 401 may also include the name of specific store franchises. It is to be understood that such user preferences may be stored or acquired in other ways. For instance, an array of codes associated with types of points of interest may be stored.

Detailed Description Text (30):
Based on the above inputs, process P410, via navigation request generator 220, route calculator 140, or another processor (not shown), determines intermediate points of interest 420 along one or more routes between current position 301 and destination 310. Intermediate points of interest 420 and dynamic condition information 430 are then inputted to process P440. Process P440 calculates costs of routes that embrace intermediate points of interest 420. Process P440 may output one or more such routes 450. Process P440 may occur at the outset of, and during navigation. For instance, when a user approaches a point of interest, the user may be notified how much additional time would be required to take a side trip. The user may then choose to be rerouted or continue along the present course. In other embodiments, a user may specify a desired time of arrival, and information relating to potential alternate routes may be supplied using the desired time of arrival as a reference. For instance, the user may be informed that an alternate route may result in the user arriving at the destination ten minutes after the desired arrival time.

Detailed Description Text (31):
FIG. 5 is a flowchart illustrating method 500 according to the present invention. In block B501, a navigation request is received from a user. In block B510, dynamic condition information associated with a route is retrieved. A desired route is determined in block B520. In block B530, the method tests whether the user is at the intended destination. If the answer is yes, then the method ceases. If the answer is no, then in block B540, the method tests whether the user wishes to take a detour. If the user does wish to take a detour, then a new navigation request is received from the user in block B501. If not, then in block B550, the method tests whether the user has entered new input or criteria. If not, then in block B510, the method continues to retrieve dynamic condition information associated with the route. If new input or criteria has been entered, then in block B560, dynamic condition information is updated, and the method returns to block B510. Accordingly, new dynamic condition information is retrieved, and a new desired route is determined in block B520.

Detailed Description Text (32):
FIG. 6 illustrates method 600 according to another embodiment of the present invention. In blocks B601 through B620, method 600 tracks blocks B501 through B520 of method 500 in FIG. 5 above. Dashed portion A includes additional steps. In block B630, a user navigates along a desired route. The speed of the user is determined in block B640. The time of arrival of the user at the destination is estimated in block B650. The user is then informed of the time of arrival in block B660.

Detailed Description Text (33):
FIG. 7 illustrates method 700 according to another embodiment of the present invention. Blocks B750 through B770 track blocks B501 through B520 of the method shown in FIG. 5 above. Dashed portion B illustrates additional steps. In block B701, a query is received from the user for a desired destination location. Dynamic condition information is retrieved based on the query in block B710. In block B720, destination locations that satisfy the query are determined. In block B730, a destination location is selected. In block B740, a navigation request is generated.

CLAIMS:

1. A method for a user to control risk in a dynamic and interactive navigation system, the method comprising: receiving, from a user, a risk factor input associated with at least one predetermined risk attribute, the risk factor input specifying a user risk filter to apply to determination of routes, wherein, if a determined route has the at least one risk attribute, then the determined route is not presented to the user, and wherein the at least one risk attribute relates to a hazard associated with a route; receiving a navigation request, the navigation request comprising a destination location description and at least one criterion to be satisfied by a desired route, wherein the at least one criterion differs from the at least one risk attribute; retrieving dynamic condition information associated with at least one route between an originating location and the destination location, the retrieving not being triggered by an input of the user; determining, according to the navigation request, at least one candidate route between the originating location and the destination location based on the dynamic condition information; applying the user risk filter to the at least one candidate route; and determining, based on the applying, the desired route

between the originating location and the destination location, wherein the desired route does not have the at least one risk attribute.

2. The method of claim 1, wherein the retrieving and the determining the desired route are iterated until the destination location is reached.

10. The method of claim 1, further comprising: presenting the dynamic condition information, retrieved by the retrieving, to the user; interactively acquiring a navigation change request, the navigation change request being specified by the user based on the dynamic condition information presented to the user by the presenting; and updating the navigation request based on the navigation change request, prior to the determining the at least one candidate route.

12. The method of claim 10, wherein the navigation change request is spoken by the user and received by a speech processing mechanism.

13. The method of claim 10, wherein the updating includes updating the destination location and the at least one criterion.

15. The method of claim 1, further comprising: navigating along the desired route, determined by the determining the desired route; determining a speed at which the user is moving towards the destination location; estimating time of arrival at the destination location based on the speed, the destination location description, and the dynamic condition information; and informing the user about the time of arrival.

16. The method of claim 1, further comprising: receiving a query from a user for at least one desired destination location; retrieving dynamic condition information based on the query; determining zero or more destination locations that satisfy the query using dynamic condition information; selecting a destination location from the zero or more destination locations by the user; and generating the navigation request based on the destination location selected by the user.

17. The method of claim 16, wherein the query specifies a type of destination location and at least one query criterion.

20. A user risk control system for dynamic and interactive navigation, the system comprising: an input mechanism, the input mechanism being configured to receive, from a user, a risk factor input associated with at least one predetermined risk attribute, the risk factor input specifying a user risk filter to apply to determination of routes, wherein, if a determined route has the at least one risk attribute, then the determined route is not presented to the user, and wherein the at least one risk attribute relates to a hazard associated with a route, the input mechanism being further configured to receive a navigation request, the navigation request comprising a destination location description and at least one criterion to be satisfied by a desired route, wherein the at least one criterion differs from the at least one risk attribute; a receiver configured to retrieve dynamic condition information associated with at least one route between an originating location and the destination location, the retrieval not being triggered by an input of the user; and a route calculator configured to determine, according to the navigation request, at least one candidate route between the originating location and the destination location based on the dynamic condition information, to apply the user risk filter to the at least one candidate route, and to determine, based on the applying, the desired route between the originating location and the destination location, wherein the desired route does not have the at least one risk attribute.

23. The system of claim 21, wherein the input mechanism includes a speech processing mechanism configured to receive a navigation request spoken by the user.

24. The system of claim 21, further comprising a navigation request generator, and wherein: the input mechanism is configured to receive a query from a user for at least one desired destination location; the receiver is configured to retrieve dynamic condition information based on the query; and the navigation request generator is configured to determine zero or more destination locations that satisfy the query using dynamic condition information, and generate the navigation request based on a destination location, selected by the user, from the zero or more destination

locations.

25. A computer-readable medium encoded with a plurality of processor-executable instruction sequences for: receiving, from a user, a risk factor input associated with at least one predetermined risk attribute, the risk factor input specifying a user risk filter to apply to determination of routes, wherein, if a determined route has the at least one risk attribute, then the determined route is not presented to the user, and wherein the at least one risk attribute relates to a hazard associated with a route; receiving a navigation request, the navigation request comprising a destination location description and at least one criterion to be satisfied by a desired route, wherein the at least one criterion differs from the at least one risk attribute; retrieving dynamic condition information associated with at least one route between an originating location and the destination location, the retrieving not being triggered by an input of the user; determining, according to the navigation request, at least one candidate route between the originating location and the destination location based on the dynamic condition information; applying the user risk filter to the at least one candidate route; and determining, based on the applying, the desired route between the originating location and the destination location, wherein the desired route does not have the at least one risk attribute.

26. The computer-readable medium of claim 25, wherein the retrieving and the determining the desired route are iterated until the destination location is reached.

27. The computer-readable medium of claim 25, further comprising processor-executable instruction sequences for: presenting the dynamic condition information, retrieved by the retrieving, to the user; interactively acquiring a navigation change request, the navigation change request being specified by the user based on the dynamic condition information presented to the user by the presenting; and updating the navigation request based on the navigation change request, prior to the determining the at least one candidate route.

28. The computer-readable medium of claim 25, further comprising processor-executable instruction sequences for: navigating along the desired route, determined by the determining the desired route; determining the speed at which the user is moving towards the destination location; estimating time of arrival at the destination location based on the speed, the destination location description, and the dynamic condition information; and informing the user about the time of arrival.

29. The computer-readable medium of claim 25, further comprising processor-executable instruction sequences for: receiving a query from a user for at least one desired destination location; retrieving dynamic condition information based on the query; determining zero or more destination locations that satisfy the query using dynamic condition information; selecting a destination location from the zero or more destination locations by the user; and generating the navigation request based on the destination location selected by the user.

30. The method of claim 29, wherein the query specifies a type of destination location and at least one query criterion.

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L14: Entry 46 of 56 File: USPT Nov 2, 1999

DOCUMENT-IDENTIFIER: US 5978732 A
TITLE: On-vehicle path guide apparatus and path search method

Abstract Text (1):
In an on-vehicle path guide apparatus and a path search method, by using path search network data and path search index data, path search index data searching device searches for a recommended path from a current position of an own vehicle to a set destination in stages and at high speed so as to guide a passenger. The data are selectively used according to a distance to the destination to efficiently search for the recommended path. The path search index data has a hierarchical structure, and a small capacity memory is mounted.

Brief Summary Text (3):
The present invention relates to an on-vehicle path guide apparatus and a path search method for searching for a recommended path between a current position and a destination at high speed so as to display the path on a map on a display unit such as liquid crystal display or CRT display.

Brief Summary Text (6):
A traffic information receiver 412 receives, for example, road traffic information sent from a traffic information center through a transmitter mounted to a road guide sign, a signal post, or the like. A compact disc player 413 is used as a read-only external storage containing information such as road map data. A CRT display 414 displays data such as various road traffic information which are converted into display signals in the processor 411. In an operating portion 415, a passenger can input a command by an input equipment such as key switch or light-pen. A self-contained navigation type position sensor 416 includes a geomagnetic sensor, a vehicle speed sensor, and so forth.

Brief Summary Text (7):
In the conventional on-vehicle path guide apparatus shown in FIG. 41, processing is carried out to retrieve depending upon the data such as road traffic information, and a recommended path obtained as a result of processing is provided for the passenger. For this purpose, the recommended path is retrieved and extracted by sequentially executing the following three steps: the first step of determining candidate paths between a current position and a destination, the second step of retrieving a path in which a predetermined condition is met from the candidate paths, and the third step of extracting the recommended path from the paths detected as a result of retrieval in the second step depending upon the various types of traffic information and a path selecting condition. Subsequently, for example, the resultant recommended path and the various types of road traffic information are visually displayed on a display unit such as liquid crystal display or CRT display, or are provided for the passenger through voice via speaker or the like.

Brief Summary Text (8):
The conventional on-vehicle path guide apparatus has the above structure. Hence, when the path search is made, a path cost must be calculated with respect to all the candidate paths depending upon data such as width of a road defined in road map data, length of a road in each section, and the type of road (such as city road, or national road). Consequently, a considerable time is required to provide the passenger with the recommended path to the destination. As a result, there is a problem in that a long time is elapsed before the recommended path is provided for the passenger.

Brief Summary Text (12):
In order to overcome the above problems, it is an object of the present invention to provide an on-vehicle path guide apparatus which can rapidly search for and provide a recommended path for a passenger, can provide the recommended path for the passenger whenever necessary even in the course of search for the recommended path from a current position to a destination, and requires a smaller memory.

Brief Summary Text (13):
According to one preferred embodiment of the present invention, for achieving the above-mentioned objects, there is provided an on-vehicle path guide apparatus in which path search index data searching means searches at high speed for a recommended path from a main road near a current position to a main road near a destination by using road network data in path search road network data storage means and path search index data stored in path search index data storage means and created with path information to each intersection as index, and a result of search is provided for a passenger through indicating means.

Brief Summary Text (14):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which path information to each area is stored in the form of path search index data in path search index data storage means, and path search index data searching means searches for a recommended path from a main road in the vicinity of a current position of an own vehicle to an area in which a destination is located by using the data.

Brief Summary Text (15):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which, even while path search index data searching means is searching for a recommended path to a destination, path search control means indicates a recommended path obtained by a search to a passenger whenever necessary each time a predetermined condition is met.

Brief Summary Text (16):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which, when a distance from a terminal link of a recommended path obtained by a search made by path search index data searching means to a destination is equal to or less than a predetermined distance, path search control means controls such that path search road network data searching means searches for the recommended path to the destination by using path search road network data.

Brief Summary Text (17):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which path search hierarchical index data including hierarchial path information to each area is stored in path search hierarchical index data storage means, and path search hierarchical index data searching means searches for a recommended path from a main road closest to a current position of an own vehicle to a main road closest to a destination at high speed by using the path search hierarchical index data.

Brief Summary Text (19):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which path search control means controls such that path search index data searching means searches for a recommended path by using path search index data and path search network data depending upon a direction in which an own vehicle travels from nodes at both ends of a link including a current position of the own vehicle, selects a recommended path having a lower cost value from among obtained recommended paths from the nodes at the both ends so as to avoid a U-turn as far as possible, and indicates the path to a passenger through indicating means.

Brief Summary Text (20):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which data of a recommended path which has been

obtained by a search is stored in recommended path storage means, path deviation detecting means detects deviation of a current position from the recommended path, and path search control means controls such that path search index data searching means searches for a path from a point where an own vehicle deviates from the recommended path to a destination or the original recommended path by using the data of the recommended path and path search index data. Even when the own vehicle deviates from the recommended path, the path to the destination or the original recommended path is provided for the passenger as far as possible.

Brief Summary Text (21):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which data of a recommended path is stored in recommended path storage means, path search control means sets a point on the recommended path within a predetermined range from a current position of an own vehicle as a destination, and alternative path searching means makes a path search by setting a cost of the recommended path higher and efficiently searches for an alternative path.

Brief Summary Text (22):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which data of a recommended path is stored in recommended path storage means, and by using traffic information received by traffic information receiving means, dynamic path searching means sets a point on the recommended path within a predetermined range from a current position of an own vehicle as a destination to calculate a recommended path cost in which the dynamic traffic information is reflected and search for the recommended path.

Brief Summary Text (23):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which data of a recommended path is stored in recommended path storage means, path deviation detecting means detects that an own vehicle deviates from the recommended path, and a travel path after the own vehicle deviates from the recommended path and a destination are stored in deviation travel path storage means. Further, when the travel path deviates from the recommended path to the same destination the predetermined number of times or more, index data changing means changes path search index data such that the vehicle passes along the travel path, and the changed data is stored in path search index data storage means, thereby including an alternative path, for example, chosen according to a passenger's taste or frequently used to pass in the recommended path.

Brief Summary Text (24):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which path search control means makes a path search from a plurality of destination representative points selected from among road network data to all links in network data, and a result of path search is stored in the path search control means. Further, the path search control means selects a destination representative point closest to a destination set by setting means, searches a result of path search for selection of the recommended path until an own vehicle approaches a point at a predetermined distance from the destination, and sequentially reads the recommended path leading to the destination representative point. Further, indicating means indicates the recommended path leading to the destination set by the setting means from a start point.

Brief Summary Text (25):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which a road on road network data is divided into a plurality of groups which are geographically in close to each other. If there is a destination representative point providing completely the same optimal path in the group, the same path search index data to the destination representative point is representatively stored in path search index data storage means. If there are a plurality of destination representative points having a small difference between optimal paths in the group, a difference in optimal path data is calculated between the destination representative points. The path search index data in which one optimal path to the destination representative point is expressed by the differential data to the other optimal path is stored in the path search index data storage means. As a

result, it is possible to set a memory size smaller.

Brief Summary Text (26):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which one case where a destination representative point is located inside a group is distinguished from the other case where located outside the group, and path search index data about a path to the destination representative point is divided to be stored in path search index data storage means. As a result, it is possible to set a memory size smaller.

Brief Summary Text (27):
According to another preferred embodiment of the present invention, there is provided an on-vehicle path guide apparatus in which in path search index data storage means is stored higher-hierarchy level road network data for retrieving a long-distance destination point obtained by selecting many roads included in an optimal path leading to a destination representative point at a long distance from among data of the optimal path obtained by a previous search. As a result, it is possible to search for a recommended path at high speed by using the higher-hierarchy level road network data.

Brief Summary Text (28):
According to another preferred embodiment of the present invention, there is provided a path search method including the steps of searching for a recommended path from a link closest to a current position of an own vehicle to a main link closest to a destination by using network data about a road attribute and connection of a main road and path search index data serving as path information between a link and a node, and indicating the recommended path obtained by the search to a passenger. As a result, it is possible to search for the recommended path at high speed.

Brief Summary Text (29):
According to another preferred embodiment of the present invention, there is provided a path search method in which one search method of searching for a recommended path from a link closest to a current position of an own vehicle to a main link closest to a destination by using path search index data, and the other search method by using path search road network data are selectively used depending upon a distance to the destination. As a result, it is possible to efficiently search for the recommended path and indicate the path to a passenger at high speed.

Brief Summary Text (30):
According to another preferred embodiment of the present invention, there is provided a path search method in which, each time a predetermined condition is met during a search for a recommended path to a destination, a recommended path obtained during the search for the recommended path is provided for a passenger whenever necessary. As a result, it is possible to efficiently and rapidly indicate the recommended path to the passenger.

Brief Summary Text (31):
According to another preferred embodiment of the present invention, there is provided a path search method in which, when a distance from a terminal link of a recommended path to a destination is equal to or less than a predetermined distance, a search is made for the recommended path by using path search road network data.

Drawing Description Text (7):
FIG. 6 is an explanatory view showing illustrative display of the path search road network data, a position of a vehicle, and a position of a destination;

Drawing Description Text (30):
FIG. 29 is an explanatory view showing a correspondence between the traffic information data showing, for example, traffic jam and regulation, and path search road network data;

Detailed Description Text (4):
FIG. 1 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 1 of the present invention. In the drawing, reference numeral 1 means current position detecting means, 2 is destination setting means (setting means), 3 is

path search control means, 5 is path search index data searching means, 6 is path search road network data storage means, 7 is path search index data storage means, and 8 is indicating means.

Detailed Description Text (5):
In the on-vehicle path guide apparatus according to the embodiment 1, a search is made for recommended paths from a current position to an intersection in the vicinity of a destination and from the intersection in the vicinity of the destination to the destination in stages and at high speed by using road network data of a main road and path search road network data serving as information about the network data which are previously stored in the path search road network data storage means 6, and path search index data (see FIG. 5, which will be described in detail) previously stored in the path search index data storage means 7. Subsequently, the obtained recommended path is provided for a passenger through the indicating means 8.

Detailed Description Text (6):
It must be noted that a structure of the current position detecting means 1 in the on-vehicle path guide apparatus shown in FIG. 1 and a current position detecting system should not be limited as long as the current position of a vehicle can be provided. For example, the present invention may employ an apparatus using a GPS receiver disclosed in JP-A 63/171377, or an apparatus to detect the position of the vehicle by using a distance sensor, a direction sensor, and map data disclosed in JP-A 63/148115.

Detailed Description Text (7):
Further, it is to be noted that a structure of the destination setting means 2 and a destination setting system should not be limited as long as information of the destination set by the passenger can be transmitted to the path search control means 3. For example, the present invention may employ a controller used by the passenger to set the destination like a control portion (setting means) 22 shown in FIG. 2.

Detailed Description Text (8):
The path search control means 3 controls the operation of the path search index data searching means 5 to search for the recommended path from the current position to the destination in stages so as to transmit the obtained recommended path to the indicating means 8.

Detailed Description Text (9):
The path search index data searching means 5 searches for a recommended path between two points set by the path search control means 3 by using the path search index data previously stored in the path search index data storage means 7. In a specific search method which will be discussed in detail, when map data shown in FIG. 4, that is, index data about the road network data corresponds to index data shown in FIG. 5, it can be understood that the vehicle may travel toward a link 15 while referring to index data of a node ml connected to a link 11 in order to move from the link 11 to a node A. Further, while referring to data of a node m2 connected to the link 15, the next connecting link may be found. This may recursively be repeated to determine a route to the destination.

Detailed Description Text (10):
FIG. 2 is a block diagram showing a specific configuration of the on-vehicle path guide apparatus according to the embodiment 1 shown in FIG. 1. In the drawing, reference numeral 21 means a GPS receiver, 22 is an operating portion, 23 is a control portion, 24 is an input circuit, 25 is a memory (working memory) used at a time of, for example, calculation of the recommended path, 26 is a CPU, 27 is an output circuit, and 28 is a road network data storage portion including the path search road network data storage means 6 and the path search index data storage means 7 shown in FIG. 1. Reference numeral 29 means a display portion.

Detailed Description Text (11):
The GPS receiver 21 corresponding to the current position detecting means 1 receives radio waves emitted from GPS (Global Positioning System) satellites, and transfers received information to the control portion 23. The operating portion 22 corresponding to the destination setting means 2 includes an input equipment such as key switch, light-pen, or infrared ray touch switch, and transmits a control signal generated

depending upon inputted information to the control portion 23. The memory 25 serves as a working area for operation.

Detailed Description Text (17):
The indicating means 8 indicates to the passenger vehicle current position information transmitted from the current position detecting means 1, road network data transmitted from the path search index data storage means 7, and the recommended path obtained as a result of search by the path search control means 3. As disclosed in, for example, JP-A 1/161111, the indicating means 8 includes the display portion 29 shown in FIG. 2 and a display control circuit thereof, and has the functions of displaying a road map with enlargement or reduction, a path while overlapping it on the map, a map selection menu for input of the destination, the destination, the current position of the vehicle, a direction of the vehicle, and so forth.

Detailed Description Text (19):
FIG. 3 is a flowchart illustrating the operation of the on-vehicle path guide apparatus according to the embodiment 1, showing the operation in which the path search index data and the path search road network data are used to search for the recommended path from the current position to the destination set by the passenger in stages, and the recommended path obtained by the search is indicated to the passenger.

Detailed Description Text (20):
First, the passenger uses the destination setting means 2 to set a desired destination (step ST301). Next, current position data of the vehicle is fetched from the current position detecting means 1 (step ST302).

Detailed Description Text (21):
Subsequently, path search road network data and path search index data corresponding to the current position obtained in step ST302 are read from the path search road network data storage means 6 and the path search index data storage means 7 (step ST303).

Detailed Description Text (22):
Next, a node closest to the current position fetched in step ST302 is retrieved by using the path search network data read in step ST303, and the retrieved node is set as a point 1 (step ST304).

Detailed Description Text (23):
FIG. 6 is a diagram showing the path search road network data fetched in step ST303. For example, when reference mark .DELTA. means the current position obtained in step ST302, the node closest to the current position is the node m1 so that the node m1 is set as the point 1. Further, processing is carried out to read path search road network data corresponding to the destination obtained in step ST301 and specified by the passenger (step ST305).

Detailed Description Text (24):
Then, a node closest to the destination obtained in step ST301 and specified by the passenger is retrieved from among the path search road network data read and obtained from the path search road network data storage means 6 in step ST305, and the node obtained by the retrieval is set as a point 2 (step ST306). For example, when reference mark .star-solid. means the destination obtained in step ST301 in FIG. 6, a node closest to the destination is a node m4 so that the node m4 is set as the point 2.

Detailed Description Text (27):
If it is shown as a result of step ST310 that all the roads can not reach the destination, the result means failure of search. Thus, the operation proceeds to step ST312 to indicate a message to this effect.

Detailed Description Text (29):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 1, it is possible to search for the recommended paths from the current position to the intersection in the vicinity of the destination and from the intersection in the vicinity of the destination to the destination in stages and at high speed by using

the road network data of the main road and the path search road network data serving as the information about the road network data and the path search index data, and provide the obtained recommended paths for the passenger.

Detailed Description Text (31):
FIG. 7 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 2 of the present invention. In the drawing, reference numeral 71 means current position detecting means, 72 is destination setting means (setting means), 73 is path search control means, and 74 is path search road network data searching means for searching an optimal recommended-path having the shortest distance traveled or having the shortest time required to travel between two points set by the path search control means. Reference numeral 75 means path search index data searching means, 76 is path search road network data storage means, 77 is path search index data storage means, and 78 is indicating means.

Detailed Description Text (32):
In the on-vehicle path guide apparatus according to the embodiment 2 shown in FIG. 7, the path search control means 73 controls the operations of the path search road network data searching means 74 and the path search index data searching means 75 to search for a recommended path from a current position of an own vehicle to a destination set by a passenger through the destination setting means 72 in stages so as to transmit the obtained recommended path to the indicating means 78.

Detailed Description Text (34):
In the on-vehicle path guide apparatus according to the embodiment 2, path search index data in the path search index data storage means 77 and path search road network data in the path search road network data storage means 76 are used to find a distance traveled from the current position to an optional intersection in the vicinity of the destination, and search for a recommended path to the destination at high speed while changing a search method according to the distance traveled so as to provide the obtained recommended path for the passenger through the indicating means 78.

Detailed Description Text (37):
First, the passenger uses the destination setting means 72 to set a desired destination (step ST801). Next, current position data of a vehicle is obtained through the current position detecting means 71 (step ST802). Subsequently, path search road network data and path search index data corresponding to the current position obtained in step ST802 are read from the path search road network data storage means 76 and the path search index data storage means 77 (step ST803).

Detailed Description Text (38):
Next, a node closest to the current position obtained in step ST802 is retrieved by using the path search network data inputted in step ST803, and the node obtained by retrieval is set as a point 1 (step ST804). If the path search road network data fetched in step ST803 is, for example, map data shown in FIG. 6, and reference mark .DELTA. means the current position fetched in step ST802, the node closest to the current position is a node m1 so that the node m1 is set as the point 1.

Detailed Description Text (39):
Further, path search road network data corresponding to the destination specified by the passenger in step ST801 is read from the path search road network data storage means 76 (step ST805). Then, a node closest to the destination obtained in step ST801 and desired by the passenger is retrieved from the path search road network data read in step ST805, and the retrieved node is set as a point 2 (step ST806). For example, when reference mark .star-solid. means the destination fetched in step ST801, the node closest to the destination is a node m4 so that the node m4 is set as the point 2.

Detailed Description Text (40):
For the next step, a distance in a straight line between the destination obtained in step ST801 and the current position obtained in step ST802 is calculated to set a result of calculation in a variable L (step ST807). For example, when the current position fetched in step ST802 is (X1, Y1), and the destination set in step ST801 is (X2, Y2), the distance L in the straight line between the current position and the destination can be found by the following expression: ##EQU1##

Detailed Description Text (43):
If the result of decision in step ST808 is NO, processing is carried out to find an area in which the destination obtained in step ST801 is located. The area may include an area obtained depending upon division according to an administrative section such as prefecture or town, or an area divided according to a mesh-type structure to have a specified size and a unique area number (step ST810).

Detailed Description Text (45):
If it is shown as a result of step ST813 that all the roads can not reach the destination, the result is regarded as failure of search, and the operation proceeds to step ST815. Further, the point 3 found in step ST813 is compared with the point 2 found in step ST806. If both points are the same point, the result is regarded as completion of search, and the operation proceeds to step ST815. If not the same point, the operation proceeds to step ST812.

Detailed Description Text (47):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 2, it is possible to find the distance traveled from the current position to the optional intersection in the vicinity of the destination by using the path search index data and the path search road network data, and search for the recommended path to the destination at high speed while changing the search method according to the distance traveled so as to provide the obtained recommended path for the passenger through the indicating means 78.

Detailed Description Text (50):
In the on-vehicle path guide apparatus according to the embodiment 3, while searching for a recommended path from a current position to a destination by using path search index data and path search road network data, a decision of the recommended path obtained by a search is made depending upon a predetermined decision condition, and the recommended path which matches the decision condition is indicated to a passenger through indicating means 8 whenever necessary for a guide to the recommended path.

Detailed Description Text (53):
First, the passenger uses destination setting means 2 to set a desired destination (step ST901). Next, current position information of a vehicle is inputted through current position detecting means 1 (step ST902).

Detailed Description Text (54):
Subsequently, path search road network data and path search index data corresponding to the current position obtained in step ST902 are read from the path search road network data storage means 6 and the path search index data storage means 7 (step ST903).

Detailed Description Text (55):
Next, a node closest to the current position obtained in step ST902 is retrieved by using the path search network data read in step ST903, and the retrieved node is set as a point 1 (step ST904). For example, if the path search road network data obtained in step ST903 is map data shown in FIG. 6, and reference mark .DELTA. means the current position fetched in step ST902, the node closest to the current position is a node m1 so that the node m1 is set as the point 1.

Detailed Description Text (56):
Further, path search road network data corresponding to the destination specified by the passenger in step ST901 is read from path search road network data storage means 6 (step ST905).

Detailed Description Text (57):
Then, a node closest to the destination obtained in step ST901 and desired by the passenger is retrieved from among the path search road network data read in step ST905, and the retrieved node is set as a point 2 (step ST906). For example, when reference mark .star-solid. in FIG. 6 means the destination fetched in step ST901, the node closest to the destination is a node m4 so that the node m4 is set as the point 2.

Detailed Description Text (58):

For the next step, processing is carried out to find an area in which the destination obtained in step ST901 is located. The area may include an area obtained depending upon division according to an administrative section such as prefecture or town, or an area divided according to a mesh-type structure to have a specified size and a unique area number (step ST907). Next, a point 3 is set as a temporary point. First, the point 1 is set as the temporary point (step ST908).

Detailed Description Text (60):
Further, path search index data corresponding to the point 3 is selected from among the path search index data read in step ST903 (step ST909). With respect to the path search index data selected in step ST909, a node connected to a road which can reach the area found in step ST908 is newly set as the point 3. At the time, information corresponding to the reachable road such as a link number, the type of road, the type of link are found depending upon the path search road network data obtained in step ST903, and the link number is stored. If it is shown in step ST910 that all the roads can not reach the destination, the result is regarded as failure of search, and the operation proceeds to step ST914 (step ST910).

Detailed Description Text (64):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 3, it is possible to make the decision of the recommended path obtained by the search depending upon the predetermined decision condition while searching for the recommended path from the current position to the destination, and indicate the recommended path which matches the decision condition to the passenger through the indicating means 8 whenever necessary, resulting in an efficient guide to the recommended path.

Detailed Description Text (67):
In the on-vehicle path guide apparatus according to the embodiment 4, path search index data is used to search for a recommended path to an area in the vicinity of a destination, and path search road network data is used to search for a recommended path to the destination according to a distance from the area to the destination. That is, a search is made for the recommended path at high speed while changing a method of searching for the recommended path according to the distance from a position of an own vehicle to the destination.

Detailed Description Text (70):
First, the passenger uses destination setting means 72 to set a desired destination (step ST1101). Next, current position information of the vehicle is obtained through current position detecting means 71 (step ST1102). Subsequently, path search road network data and path search index data corresponding to the current position obtained in step ST1102 are read from path search road network data storage means 76 and path search index data storage means 77 (step ST1103).

Detailed Description Text (71):
Next, a node closest to the vehicle current position obtained in step ST1102 is retrieved by using the path search network data obtained in step ST1103, and the retrieved node is set as a point 1 (step ST1104).

Detailed Description Text (72):
For example, if a map shown in FIG. 6 is the path search road network data fetched in step ST1103, and reference mark .DELTA. means the current position obtained in step ST1102, the node closest to the current position is a node m1 so that the node m1 is set as the point 1.

Detailed Description Text (73):
Further, path search road network data corresponding to the destination obtained in step ST1101 and desired by the passenger is read from the path search road network data storage means 76 (step ST1105). Then, a node closest to the destination obtained in step ST1101 and desired by the passenger is retrieved from among the path search road network data read in step ST1105, and the retrieved node is set as a point 2 (step ST1106). For example, when reference mark .star-solid. shown in FIG. 6 means the destination obtained in step ST1101, the node closest to the destination is a node m4 so that the node m4 is set as the point 2.

Detailed Description Text (74):
For the next step, processing is carried out to find an area in which the destination obtained in step ST1101 is located. The area may include an area obtained depending upon division according to an administrative section such as prefecture or town, or an area divided according to a mesh-type structure to have a specified size and a unique area number (step ST1107). Next, a point 3 is set as a temporary point. First, the point 1 is set as the point 3 (step ST1108). Subsequently, a distance in a straight line between the destination obtained in step ST1101 and the current position obtained in step ST1102 is calculated to set the result of calculation to a variable L.

Detailed Description Text (75):
For example, when the current position obtained in step ST1102 is (X1, Y1), and the destination set in step ST1101 is (X2, Y2), the distance L in the straight line between the current position and the destination can be found by the following expression (step ST1109): ##EQU2##

Detailed Description Text (79):
With respect to the path search index data obtained in step ST1112, a node connected to a road which can reach the area found in step ST1107 is newly set as the point 3. At the time, a link number corresponding to the reachable road is found depending upon the path search road network data read in step ST1103, and the link number is stored. Thereafter, the operation proceeds to step ST1109. If it is shown in the step that all the roads can not reach the destination, the result is regarded as failure of search, and the operation proceeds to step ST1114 (step ST1113).

Detailed Description Text (81):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 4, it is possible to find the recommended path from the current position to the optional node in the area in which the destination is located by using the path search index data and the path search road network data, and subsequently search for the recommended path to the destination while changing the method of searching for the recommended path according to the distance to the destination. It is thereby possible to search for the recommended path at high speed and provide the obtained recommended path for the passenger through the indicating means.

Detailed Description Text (83):
FIG. 12 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 5 of the present invention. In the drawing, reference numeral 125 means path search hierarchical index data searching means, and 127 is path search hierarchical index data storage means. Further, reference numeral 121 means current position detecting means, 122 is destination setting means (setting means), 123 is path search control means, 126 is path search road network data storage means, and 128 is indicating means. These component parts have the same functions as those of the current position detecting means 1, the destination setting means 2, the path search control means 3, and indicating means 8, and descriptions thereof are omitted.

Detailed Description Text (84):
The path search hierarchical index data searching means 125 searches for a recommended path between two points set by the path search control means 123 by using path search hierarchical index data stored in the path search hierarchical index data storage means 127. Specifically, in one search method, when data shown in FIG. 14 is index data of map data shown in FIG. 4, it can be understood that a vehicle may travel toward a link 15 while referring to index data of a node m1 connected to a link 11 in order to move from the link 11 in a direction of A. Further, data of a node m2 connected to the link 15 is referred to find the next connecting link. This is recursively repeated to determine a route to the destination. At the time, if higher order index data is found at each node of path search hierarchical index data which will be described infra, the operation moves up to the higher order index data to continue the search.

Detailed Description Text (89):
In the on-vehicle path guide apparatus according to the embodiment 5, the path search hierarchical index data stored in the path search hierarchical index data storage means 127 and the path search road network data stored in the path search road network data storage means 126 are used to search for a recommended path from a current

position of an own vehicle to a destination set by the passenger in stages, and the recommended path obtained by the search is rapidly indicated through the indicating means 128.

Detailed Description Text (91):
In FIG. 12, the path search hierarchical index data stored in the path search hierarchical index data storage means 127 and the path search road network data stored in the path search road network data storage means 126 are used to search for the recommended path from the current position of the own vehicle to the destination set by the passenger in stages, and the recommended path obtained by the search is indicated to the passenger. The operation will be described with reference to the flowchart shown in FIG. 3.

Detailed Description Text (92):
First, the passenger uses the destination setting means 122 to set a desired destination (step ST301).

Detailed Description Text (93):
Next, current position data of the vehicle is obtained through the current position detecting means 121 (step ST302).

Detailed Description Text (94):
Subsequently, path search road network data and path search index data corresponding to the current position obtained in step ST302 are read from the path search road network data storage means 126 and the path search hierarchical index data storage means 127 (step ST303).

Detailed Description Text (95):
Next, a node closest to the current position fetched in step ST302 is retrieved by using the path search network data read in step ST303, and the retrieved node is set as a point 1 (step ST304).

Detailed Description Text (96):
For example, when map data shown in FIG. 6 is the path search road network data fetched in step ST303, and reference mark .DELTA. means the current position fetched in step ST302, the node closest to the current position is the node m1 so that the node m1 is set as the point 1. Further, processing is carried out to read path search road network data corresponding to the destination obtained in step ST301 and desired by the passenger (step ST305).

Detailed Description Text (97):
Then, a node closest to the destination fetched in step ST301 and specified by the passenger is retrieved from among the path search road network data read in step ST305, and the node obtained by the retrieval is set as a point 2 (step ST306). For example, when reference mark .star-solid. means the destination obtained in step ST301, the node closest to the destination is a node m4 so that the node m4 is set as the point 2.

Detailed Description Text (98):
For the next step, processing is carried out to find an area in which the destination obtained in step ST301 is located. The area may include an area obtained depending upon division according to an administrative section such as prefecture or town, or an area divided according to a mesh-type structure to have a specified size and a unique area number. Next, a point 3 is set as a temporary point. First, the point 1 is set as the point 3 (step ST308). Subsequently, path search index data corresponding to the point 3 is selected from among the path search index data read in step ST303 (step ST309).

Detailed Description Text (100):
If it is shown in step ST310 that all the roads can not reach the destination, lower order index data is read to continue the search. If no lower order index data can be found, the result is regarded as failure of search, and the operation proceeds to step ST312. Further, the point 3 obtained in step ST310 is compared with the point 2 obtained in step ST306. If both points are the same point, the result is regarded as completion of search, and the operation proceeds to step ST312. If not the same point,

the operation proceeds to step ST309 (step ST311).

Detailed Description Text (102):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 5, it is possible to efficiently search for the recommended paths from the current position of the own vehicle to the destination set by the passenger in stages by using the path search hierarchical index data having a hierarchical structure and the path search road network data, and rapidly indicate the recommended path obtained by the search through the indicating means.

Detailed Description Text (106):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 6, it is possible to search for a recommended path from a start point to a destination, having a characteristic desired by a passenger. Further, it is possible to search for the recommended path which matches a condition desired by the passenger at high speed by switching of the index data, and provide the obtained recommended path for the passenger.

Detailed Description Text (109):
In the on-vehicle path guide apparatus according to the embodiments 1 to 6, when a search is made with a node closest to a current position of an own vehicle as a starting point, a recommended path starting from a position in front of the own vehicle may not be obtained. In the on-vehicle path guide apparatus according to the embodiment 7, processing is carried out to select nodes positioned in a direction in which the vehicle travels and in both directions on a link on which the own vehicle is positioned, that is, in directions of the front and the rear of the own vehicle, and efficiently search for a recommended path along which the own vehicle can reach a destination without a U-turn depending upon index data of the nodes so as to provide the obtained recommended path for a passenger through indicating means.

Detailed Description Text (112):
First, the passenger uses destination setting means 2 to set a desired destination (step ST1601). Next, path search road network data and path search index data corresponding to the current position obtained in step ST1601 are read from path search road network data storage means 6 and path search index data storage means 7 (step ST1602).

Detailed Description Text (113):
Subsequently, vehicle information such as position and direction of the vehicle are obtained through current position detecting means 1 (ST1603). Depending upon the vehicle information obtained in step ST1603, a link located in the closest proximity to the vehicle is retrieved from the path search road network data (step ST1604). Further, with respect to the closest link obtained in step ST1604, a decision is made of vehicle direction (up and down) with respect to the closest link depending upon the vehicle information obtained in step ST1603. In one decision method, as shown in an explanatory view of FIG. 17, the decision is made by comparing an angle of the link with the direction of the vehicle (step ST1605).

Detailed Description Text (114):
Further, processing is carried out to fetch path search index data of the nodes positioned in the directions of the front and the rear of the vehicle on the closest link (step ST1606), and information to the destination are obtained with respect to the index data fetched in step ST1606. "Information to the destination" as used herein means information showing whether or not the vehicle can reach the destination. If the vehicle can reach the destination with respect to only one of the index data, the operation proceeds to step ST1608. If the vehicle can reach the destination with respect to both the index data, the operation proceeds to step ST1609. If the vehicle can not reach the destination with respect to both the index data, the search to the destination is impossible. Then, a message to this effect is indicated to the passenger through indicating means 8, and the operation is ended (step ST1607).

Detailed Description Text (115):
When the information obtained in step ST1607 shows that the vehicle can reach with respect to only one of the index data, it is decided that a U-turn is unnecessary if the index data belongs to the node in front of the vehicle or that the U-turn is

necessary if the index data belongs to the node behind the vehicle, and a search from the front node or the rear node to the destination is made through a retrieval method (steps ST303 to ST311 in FIG. 3) shown in the embodiment 1. When the search to the destination is completed, the operation proceeds to step ST1612 (step ST1608).

Detailed Description Text (116):
When the information obtained in step ST1607 shows that the vehicle can reach with respect to both the nodes, a search is made for recommended paths with respect to the index data of the front and rear nodes according to the method described in the embodiment 1 (step ST1609). When the path from the front node and the path from the rear node to the destination are found in the course of the search, or both the paths come into contact with each other in the course of the search, costs of both the paths are found. The cost is found depending upon, for example, a link length or a link width of a link forming the path. In general, the cost of a road becomes lower as the vehicle can more easily travel on the road, and the cost of the road becomes higher as travel on the road becomes more difficult. Further, a value serving as a U-turn cost is added to the cost of the path from the rear node (step ST1610).

Detailed Description Text (119):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 7, it is possible to select the nodes in the direction in which the vehicle travels and in both the directions on the link on which the own vehicle is positioned, and efficiently search for the recommended path along which the own vehicle can reach the destination without the U-turn depending upon the index data of the nodes so as to provide the obtained recommended path for the passenger through the indicating means.

Detailed Description Text (121):
FIG. 18 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 8. In the drawing, reference numeral 184 means recommended path storage means, 189 is path deviation detecting means, and 190 is path search road network data searching means. Further, current position detecting means 181, destination setting means (setting means) 182, path search control means 183, path search road network data storage means 186, indicating means 188, path search hierarchical index data searching means 185, and path search hierarchical index data storage means 187 are identical with the current position detecting means 1, the destination setting means 2, the path search control means 3, the path search road network data storage means 6, and the indicating means 8 in the on-vehicle path guide apparatus according to the embodiment 1 shown in FIG. 1 and the path search hierarchical index data searching means 125 and the path search hierarchical index data storage means 127 in the on-vehicle path guide apparatus according to the embodiment 5 shown in FIG. 12. Therefore, descriptions thereof are omitted.

Detailed Description Text (122):
In the recommended path storage means 184 is stored a recommended path obtained by the path search index data searching means 5 shown in FIG. 1 or the path search hierarchical index data searching means 185 shown in FIG. 18 and the path search road network data searching means 190. In the path deviation detecting means 189, it is decided whether or not an own vehicle is positioned on a path depending upon the recommended path stored in the recommended path storage means 184 and current position information obtained by the current position detecting means 181.

Detailed Description Text (123):
In the on-vehicle path guide apparatus according to the embodiment 8, the path deviation detecting means 189 detects that a passenger deviates from the recommended path, and a search is made for a path from a position where the deviation is detected to a destination or an original recommended path by using path search index data so as to provide a result of search for the passenger.

Detailed Description Text (126):
First of all, a search is made for a recommended path according to the search method shown in the embodiment 1, and the recommended path obtained by the search is stored in the recommended path storage means 184 (step ST1901). Next, vehicle information such as position of the own vehicle and vehicle direction of the own vehicle are obtained from the current position detecting means 181 (step ST1902).

Detailed Description Text (129):
With respect to the index data fetched in step ST1904, information to the destination is obtained. "Information to the destination" as used herein means information showing whether or not the vehicle can reach the destination. If the vehicle can reach the destination with respect to only one of the index data, the operation proceeds to step ST1906. If the vehicle can reach the destination with respect to both the index data, the operation proceeds to step ST1908. If the vehicle can not reach the destination with respect to both the index data, the search to the destination is impossible. Then, a message to this effect is indicated to the passenger through indicating means 188, and the operation is ended (step ST1905).

Detailed Description Text (130):
When the information obtained in step ST1905 shows that the vehicle can reach with respect to only one of the index data, a search to the destination from the front node if the index data belongs to the node in front of the vehicle or from the rear node if the index data belongs to the node behind the vehicle is made through the retrieval method shown in the embodiment 1. In the search, if the link or the node is found on the recommended path stored in step ST1901, the operation proceeds to step ST1907. Alternatively, if the search reaches the destination without finding the link or the node on the recommended path, the operation proceeds to step ST1911 (step ST1906).

Detailed Description Text (135):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 8, it is possible to detect that the passenger deviates from the recommended path through the path deviation detecting means, and search for the optimal path from the position where the deviation is detected to the destination or the original recommended path by using the path search index data so as to provide a result of the search for the passenger.

Detailed Description Text (137):
FIG. 20 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 9 of the present invention. In the drawing, reference numeral 201 means current position detecting means, 202 is destination setting means (setting means), 203 is path search control means, 204 is alternative path searching means for making a path search by increasing a cost of a recommended path, 205 is path search index data searching means, 206 is path search road network data storage means, 207 is path search index data storage means, 208 is indicating means, and 209 is recommended path storage means in which the recommended path is stored.

Detailed Description Text (138):
In the on-vehicle path guide apparatus according to the embodiment 9, when it is found that, for example, a traffic jam is generated on a recommended path, the path search is made by setting the cost of the recommended path higher to search for a new recommended path to bypass the above recommended path so as to provide the new path for a passenger.

Detailed Description Text (140):
FIG. 21 is a flowchart showing the operation of the on-vehicle path guide apparatus according to the embodiment 9. FIG. 22 is an explanatory view showing a road network, illustrating the operation of the on-vehicle path guide apparatus of FIG. 20. In the drawing, reference numeral 301 means a current position, 302 to 306 are links of the recommended path, 307 to 321 are links except the recommended path, and 322 to 328 are nodes.

Detailed Description Text (142):
First of all, a link corresponding to current position information detected by the current position detecting means 201 is fetched from the path search road network data storage means 206, and is set as a link 1 (step ST201).

Detailed Description Text (143):
It is decided whether or not the link 1 is included in the recommended path (step ST202). If not included, the operation is ended. In FIG. 23, the link 302 serves as the link 1. If the link 1 is included in the recommended path, a node of the link 1 on the side of the destination is selected, and is set as a node 1 (step ST203). In FIG. 23, the link 323 serves as the node 1.

Detailed Description Text (144):
Subsequently, a link on the recommended path connected to the node 1 except the link 1 is selected, and is set as a link 2 (step ST204). The set link 2 is stored in, for example, a working memory (not shown) (step ST205). A node of the link 2 on the side of the destination is selected, and is set as a node 2 (step ST206). It is decided whether or not a road distance from the node 1 to the node 2 exceeds a predetermined value (step ST207). If the road distance does not exceed the predetermined value, a link on the recommended path connected to the node 2 except the link 2 is selected, and is newly set as the link 2 (step ST208). Thereafter, the operation proceeds to step ST205.

Detailed Description Text (145):
If, in the decision in step ST207, the road distance from the node 1 to the node 2 exceeds the predetermined value, the recommended path from the node 2 to the destination is defined as a partial path, and is stored in, for example, the working memory (step ST209). In FIG. 23, when it is assumed that the node 326 becomes the node 2, the links 305 and 306 serve as the partial path.

Detailed Description Text (146):
Then, the node 2 is set as the destination, a search is made through a mathematical algorithm such as Dijkstra's algorithm by increasing costs of the stored links from the node 1 to the node 2, and the path obtained by the search is stored as the alternative path (step ST210). In FIG. 24, the links 310 and 314 serve as the alternative paths. The link 1, the alternative path stored in step ST210, and the partial path stored in step ST209 are connected to provide a new recommended path (step ST211). It is thereby possible to create the new recommended path shown in FIG. 25.

Detailed Description Text (147):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 9, when it is found that, for example, the traffic jam is generated on the recommended path, the passenger sets the cost of the recommended path higher, and the alternative path searching means makes -the path search. It is thereby possible to search for the new recommended path to bypass the above recommended path, and provide the obtained new recommended path for the passenger through the indicating means.

Detailed Description Text (149):
FIG. 26 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 10 of the present invention. In the drawing, reference numeral 261 means current position detecting means, 262 is destination setting means (setting means), 263 is path search control means, 265 is path search index data searching means, 266 is path search road network data storage means, 267 is path search index data storage means, 268 is indicating means, 269 is recommended path storage means in which a recommended path is stored, 270 is traffic information receiving means for receiving dynamic traffic information transmitted from the outside on demand, and 264 is dynamic path searching means for making a path search while reflecting the contents of the dynamic traffic information in a cost.

Detailed Description Text (150):
In the on-vehicle path guide apparatus according to the embodiment 10, a node on the recommended path is defined as a destination, and the path search is made by calculating a cost in which the dynamic traffic information is reflected so as to provide the obtained recommended path for a passenger.

Detailed Description Text (152):
FIG. 27 is a flowchart showing the operation of the on-vehicle path guide apparatus according to the embodiment 10 of the present invention. FIG. 28 is an explanatory view of a format of traffic information data received by the traffic information receiving means 270 and including a code showing an area such as secondary mesh, a road link number showing a road in the area, jam information showing the degree of traffic jam on the road, and regulation information showing whether or not the road is negotiable. FIG. 29 is an explanatory view showing a correspondence between traffic information data showing, for example, traffic jam and regulation, and path search road network data.

Detailed Description Text (153):
First of all, it is decided whether or not traffic information including a current position of an own vehicle detected by the current position detecting means 261 is received (step ST271). If not received, the operation is ended. Next, a link corresponding to the current position is selected from road network data, and is set as a link 1 (step ST272). Further, it is decided whether or not the link 1 is included in the recommended path (step ST273). If the link 1 is not included in the recommended path, the operation is ended. If included in the recommended path, a node of the link 1 on the side of the destination is selected, and is set as a node 1 (step ST274).

Detailed Description Text (154):
Subsequently, a link on the recommended path connected to the node 1 except the link 1 is selected, and is set as a link 2 (step ST275). A node of the link 2 on the side of the destination is selected, and is set as a node 2 (step ST276). It is decided whether or not information about jam or regulation is found on the link 2 (step ST277). It is possible to decide whether or not the jam and the regulation are found by converting the link 2 into a road link number of the traffic information data by using the correspondence table shown in FIG. 29. If neither the jam nor the regulation is found, it is decided whether or not a road distance from the node 1 to the node 2 exceeds a predetermined value (step ST278). If the road distance does not exceed the predetermined value, a link on the recommended path connected to the node 2 except the link 2 is selected, and is newly set as the link 2 (step ST279). Thereafter, the operation branches to step ST276.

Detailed Description Text (155):
If the road distance from the node 1 to the node 2 exceeds the predetermined value, the operation is ended. If the jam and the regulation are found, it is decided whether or not the road distance from the node 1 to the node 2 exceeds the predetermined value (step ST280). If exceeds the predetermined value, the operation branches to step ST284. If the road distance from the node 1 to the node 2 does not exceed the predetermined value, a link on the recommended path connected to the node 2 except the link 2 is selected, and is newly set as the link 2 (step ST281). A node of the link 2 on the side of the destination is selected, and is set as the node 2 (step ST282).

Detailed Description Text (156):
It is decided whether or not the jam and the regulation are found on the link 2 (step ST283). If the jam and the regulation are found, the operation branches to step ST280. If neither the jam nor the regulation is found, the recommended path from the node 2 to the destination is stored as a partial path (step ST284). Then, while adding a cost depending upon the traffic information, a search is made from the node 1 to the node 2 through a mathematical algorithm such as Dijkstra's algorithm, and the path obtained by the search is stored as a dynamic path (step ST285). The link 1, the dynamic path stored in step ST285, and the partial path stored in step ST284 are connected to provide a new recommended path (step ST286).

Detailed Description Text (157):
Though the jam information and the regulation information are used to determine the destination in the dynamic search, it is to be noted that only the regulation information may be used for the decision. Further, in case of the decision of jam, the decision may be made by selecting only a high degree of jam.

Detailed Description Text (158):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 10, it is possible to receive the dynamic traffic information through the traffic information receiving means, and define the node on the recommended path as the destination so as to calculate the cost in which the dynamic traffic information is reflected. Further, it is possible to search for the recommended path depending upon the result of the cost calculation so as to provide the obtained recommended path for the passenger through the indicating means 268.

Detailed Description Text (160):
FIG. 30 is a block diagram showing an on-vehicle path guide apparatus according to the embodiment 11 of the present invention. In the drawing, reference numeral 501 means current position detecting means, 502 is destination setting means (setting means),

503 is path search control means, 505 is path search index data searching means, 506 is path search road network data storage means, 507 is path search index data storage means, 508 is indicating means, 509 is recommended path storage means in which a recommended path is stored, 510 is path deviation detecting means for detecting that a driver deviates from the recommended path, 511 is deviation travel path storage means in which a travel path after the deviation from the recommended path is stored, and 512 is index data changing means for changing index data.

Detailed Description Text (161):
In the on-vehicle path guide apparatus according to the embodiment 11, when an own vehicle deviates from the recommended path to the same destination the predetermined number of times or more to travel along completely the same deviation path, the index data changing means stores the deviation path such as path chosen according to a driver's taste as the recommended path in the path search index data storage means, and the deviation path is provided for the passenger as the recommended path.

Detailed Description Text (163):
FIG. 31 is a flowchart showing the operation of the on-vehicle path guide apparatus according to the embodiment 11. FIG. 32 is an explanatory view showing a data structure of the deviation travel path. The deviation travel path has the data structure including coordinates of a destination when the own vehicle deviates from the recommended path, a mesh code of a deviation link, a link number, the same destination, and an area in which a count value showing the number of times a combination of links is caused is stored.

Detailed Description Text (164):
First of all, a link corresponding to own vehicle current position information detected by the current position detecting means 501 is selected from path search road network data, and is set as a link 1 (step ST501). It is decided whether or not the link 1 is included in the recommended path (step ST502). If included, the operation branches to step ST501. If the link 1 is not included in the recommended path, it is decided depending upon the coordinates of the destination whether or not the destination set in the destination setting means 502 is included in the deviation travel path (step ST503). If not included, the destination and the link 1 are stored in the deviation travel path storage means 511 (step ST505). If the destination is included in the deviation travel path, a link corresponding to the destination is selected from the deviation travel path (step ST504), and the selected link is compared with the link 1 (step ST506).

Detailed Description Text (165):
If the selected link is different from the link 1, the operation branches to step ST504. If the link selected in step ST505 is identical with the link 1, a count value of the corresponding deviation travel path is incremented by one (step ST507). It is decided whether or not the count value is equal to or more than a predetermined value (step ST508). If the count value is less than the predetermined value as a result of decision, the operation is ended. If the count value is equal to or more than the predetermined value, index data corresponding to the destination is changed to the link 1 (step ST509).

Detailed Description Text (166):
In the above discussion, as a condition of a decision of the destination, it is decided whether or not the destinations are identical. However, it may be decided that the destinations are identical as long as the index data including the destination are in the same area. In this case, destination area information is recorded in the destination in the data structure of the deviation travel path shown in FIG. 32. Further, when a difference in coordinates between the destinations is within a predetermined range, the destinations may be regarded as the same destination.

Detailed Description Text (167):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 11, when it is decided that the travel path deviating from the same destination is different from the recommended path the predetermined number of times or more, it is possible to store the deviation path as the recommended path in the path search index data storage means so as to set the recommended path. Thus, it is thereby possible to provide, for example, the recommended path chosen according to the driver's taste for

the driver.

Detailed Description Text (170):
In case of the on-vehicle path guide apparatus according to the embodiment 1, it is necessary to build a bulk storage (such as RAM) into the path search index data searching means 5 because index data to all destination areas should concurrently be stored in the memory 25 (see FIG. 2). In the on-vehicle path guide apparatus according to the embodiment 12, the index data are divided for each destination to be previously stored in path search index data storage means 7. The divided index data are sequentially read from the path search index data storage means 7 until a vehicle reaches a position at a predetermined distance from the destination. It is thereby possible to reduce a size of data which is concurrently read, and efficiently search for a recommended path at high speed.

Detailed Description Text (172):
FIG. 33 shows a structure of the index data stored and used in the path search index data storage means 7 in the on-vehicle path guide apparatus according to the embodiment 12. The index data is created for each division of a road network. In the road network, a division of a road section may include a division having a definite form such as secondary mesh (National Standard Grid Cell) used in Geographical Survey Institute or a division having an indefinite form such as division according to an administrative section. Further, the divisions may overlap each other. Index data of each division has index data for each destination area. In this case, the destination area may be identical with the division of the network, or another division obtained by subdividing the division of the network, provided that the destination areas can not overlap each other.

Detailed Description Text (173):
The index data of each destination area includes index of each intersection in the road network division, and shows an optimal path to the next intersection by specifying an outflow link with respect to a link connected to the intersection. It is possible to obtain the optimal path by setting one to several destination representative points in each destination area, and finding an optimal path from each intersection to the destination representative point. Thus, when the vehicle unnecessarily approaches the destination area, the optimal path to the destination representative point differs from the optimal path to the destination. Hence, the search using the index data is stopped before the vehicle approaches the position within the predetermined distance from the destination. In later steps, a search to the set destination is made by using a normal path search method.

Detailed Description Text (174):
FIG. 34 is a flowchart showing the operation of the on-vehicle path guide apparatus according to the embodiment 12. Referring now to the flowchart, a description will be given of a procedure for searching for the optimal path from a current position to the destination.

Detailed Description Text (175):
First, a passenger uses destination setting means 2 to set a desired destination (step ST341). Path search control means 3 specifies the destination area including the destination according to coordinates of the destination or specification from the destination setting means 2 (step ST342). Next, current vehicle position information of an own vehicle is fetched from current position detecting means 1. Network data of the road network division including a vehicle position, and index data to the destination area are respectively read from path search road network data storage means 6 and the path search index data storage means 7 (step ST343). For example, in case of a network division N of the vehicle position and a destination area M, index data N-M shown in FIG. 33 is read.

Detailed Description Text (178):
A distance in a straight line between the search intersection and the coordinates of destination is set as L. If L is less than a specified distance L1, the operation proceeds to step ST350. L is equal to or more than L1, processing is carried out in step ST347 and later steps (step ST346). Here, it is to be understood that L1 is sufficiently long as compared with the size of the destination division, and the vehicle can reach an intersection in the destination division along the same path if

the distance L is equal to or more than L1.

Detailed Description Text (180):
In step ST348, it is decided whether or not the new search node is located in the same division as the preceding network division. If the division is changed, network data and index data of a new division are read (step ST349). Thereafter, the operation returns to step ST346. In this case, index corresponding to the destination area is read. For example, when the destination area is M and the search node is in a division N' instead of the division N, index N'-M is read. If the division is not changed, the operation returns to step ST346.

Detailed Description Text (181):
In step ST350, network data from an area including the search node and to the area including the coordinates of the destination is read. Index data is not read. In step ST351, a search is made from the search node to the destination through a known search method such as Dijkstra's algorithm, or A.sup.* algorithm.

Detailed Description Text (182):
In step ST352, histories of the search node and the inflow link are connected to a result of search from a final search node to the destination, thereby creating path data from a start point to the destination and outputting the path data to display means.

Detailed Description Text (183):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 12, the index data are divided for each destination to be previously stored in the path search index data storage means. Then, it is possible to sequentially read the divided index data until the vehicle reaches the position at the predetermined distance from the destination so as to search for the recommended path. It is thereby possible to calculate the recommended path at high speed through a smaller memory, and rapidly provide the obtained recommended path for the passenger.

Detailed Description Text (189):
FIG. 35 is an explanatory view showing a structure of path search index data used in the on-vehicle path guide apparatus according to the embodiment 13. The use of the index data structure can reduce a load of an external storage unit while keeping the amount of read data small. Instead of a destination area integrally having index data in index data of each division, the destination area is grouped, and index data is set for each group. Here, it is to be understood that the index are completely matched at all intersections in the division with respect to a destination belonging to the same group. For example, in a division in the vicinity of Tokyo, it can be expected that completely the same path can be set as an optimal path for all destinations in an area such as Osaka, Hiroshima, or Kyusyu. On the other hand, the probability is high that an optimal path for a destination in Osaka will be different from an optimal path for a destination in Hiroshima when viewed from a division in the vicinity of Okayama. Hence, a grouping is uniquely made for each division.

Detailed Description Text (190):
In order to obtain index to the destination area from data shown in FIG. 35, grouping data is read to detect to which group the destination area belongs in the division, and index data corresponding to the obtained group is read.

Detailed Description Text (192):
The pointer data uniquely relates the index data or the differential data to each destination area. The destination areas belonging to the same group have a pointer with respect to the same data. The differential data includes original index data and differential data for changing the original data. In the index data structure of FIG. 36, a destination area M has a pointer to index data a, and a destination area M' has a pointer to differential data b. In order to select index of the destination M', pointer data is read to obtain the differential data b as data corresponding to the destination area M'. After the differential data b is read, the index data a is read since the differential data b has the index data a as the original data. Thus, the index data a is changed by the differential data b into index of the destination area M'.

Detailed Description Text (193):
Though the original data is changed by the differential data only once in the index data structure shown in FIG. 36, it must be noted that the processing may be carried out in several steps. For example, it is assumed that a pointer of a destination area M" shows differential data c, and original data of c is the differential data b. In this case, in order to obtain index data of the destination area M", the differential data c is read, the differential data b serving as the original data of c is read, and the index data a serving as the original data of b is read. The index data a is changed by the differential data b, and is changed by the differential data c, resulting in the index of the destination area M".

Detailed Description Text (195):
In this case, there is one method of reducing the amount of concurrently read data, in which the destination area is divided into several large divisions to create index data for each large division. For example, an entire road network is divided into the east side and the west side, and index data to the destination area on the east side and index data to the destination area on the west side are created as index of each network division. At a time of the search, data to be read is changed according to the division in which the destination area is located. Alternatively, instead of the static division as described above, there is another variable dividing method in which one destination area located within a predetermined distance from an own division (or one destination area located in the division) is distinguished from the other destination area in each network division.

Detailed Description Text (199):
When a search is made for a recommended path with a long distance from a start point to a destination, the search is made by using road network data having the hierarchical structure which is used in the index data structure according to the embodiment 5. At a time of the search, when a higher-hierarchy level road network does not appropriately include an optimal recommended-path having a long distance, another search is temporarily made while referring to a lower-hierarchy level network data in the course of the search in the higher-hierarchy level road network. For example, it is assumed that the optimal recommended-path in a certain search includes intersections a, b, c, d, e, and f in alphabetical order as shown in an explanatory view of FIG. 37.

Detailed Description Text (201):
In the on-vehicle path guide apparatus according to the embodiment 14, higher-hierarchy level road network data is created such that a recommended path with a long distance to a destination can include many optimal recommended-paths by using optimal recommended-path data obtained by a previous search, and is stored in path search index data storage means 5. Thus, the search time for the recommended path can be reduced by using the higher-hierarchy level road network data.

Detailed Description Text (205):
One destination area is selected from among destination areas (step ST393). If a distance between a start point intersection and the destination area is equal to or less than L2, the operation proceeds to step ST398 (step ST394). A path from the start point intersection to a destination representative point in the selected destination area is selected by sequentially using indexes to the destination area (step ST395). From the selected path are removed a road having a road length from the start point intersection within a specified distance L3, and a road having a road length up to the destination representative point within a specified distance L4 (step ST396). A remaining intermediate road is stored as a road to be included in the higher hierarchy network (step ST397).

Detailed Description Text (206):
If any other destination area can be found with respect to the start point intersection, the operation returns to step ST393 (step ST398). If the operations with respect to all the destination areas are completed, the operation returns to step ST392 (step ST399). If the operations with respect to all combinations are completed, the higher hierarchy road network is created by carrying out the logical OR between the roads stored in step ST397 (step ST340).

Detailed Description Text (207):

FIG. 38 shows an illustrative higher hierarchy road network obtained by performing the OR operation. In FIG. 38, the start point intersection group includes intersections S1, S2, and S3, and destination representative points D1, D2, and D3. Since the destination representative point D1 is located within a specified distance from the start point intersection S1, paths to D2 and D3 are found instead of a path to D1. An optimal path from S1 to D2 includes b, c, d, and e. Except roads located within the specified distance on the start point side and the destination side, b, c, and d are stored as roads to be included in the higher hierarchy network. Similarly, roads f and g in the path extending from S1 to D3 are stored. The same operation is performed with respect to the start point intersections S2 and S3. As a result, the higher-hierarchy level includes the roads b, c, d, f, g, h, i, and 1.

Detailed Description Text (208):
As set forth above, according to the on-vehicle path guide apparatus in the embodiment 14, in case of the long distance from the start point to the destination, the higher-hierarchy level road network data used for the search for the recommended path is formed such that the recommended path to the destination can include the many optimal recommended-paths by using the optimal recommended-path data obtained by the previous search. As a result, it is possible to reduce the search time for the recommended path so as to rapidly indicate the recommended path to a passenger.

Detailed Description Text (209):
As set forth above, according to the present invention, the path search index data searching means searches for the recommended path from the main road closest to the current position to the main road closest to the destination by using the road network data in the path search road network data storage means and the path search index data stored in the path search index data storage means and created with the path information to each intersection as the index. As a result, there is an effect in that it is possible to indicate the result of search to the passenger at high speed.

Detailed Description Text (210):
Further, according to the present invention, the path information to each area is stored in the form of the path search index data in the path search index data storage means, and the path search index data searching means searches for the recommended path from the main road in the vicinity of the current position of the own vehicle to the area in which the destination is located by using the data. As a result, there are effects in that the path search control means controls switching between the path search index data searching means and the path search road network data searching means depending upon the distance from the start point to the destination so as to efficiently search for the recommended path at high speed and reduce the amount of the index data.

Detailed Description Text (211):
Further, according to the present invention, even while the path search index data searching means searching for the recommended path to the destination, the path search control means indicates the recommended path obtained by the search to the passenger each time the predetermined condition is met. As a result, there are effects in that it is possible to search for the recommended path from the start point to the destination at high speed, and rapidly indicate the recommended path to the passenger.

Detailed Description Text (212):
Further, according to the present invention, when the distance from the terminal link of the recommended path obtained by the search made by the path search index data searching means to the destination is equal to or less than the predetermined distance, the path search control means controls such that the path search road network data searching means searches for the recommended path to the destination by using the path search road network data. As a result, there are effects in that it is possible to search for the recommended path from the start point to the destination at high speed, and reduce the amount of index data.

Detailed Description Text (213):
Further, according to the present invention, the path search hierarchical index data searching means searches for the recommended path from the main road closest to the current position of the own vehicle to the main road closest to the destination by

using the path search hierarchical index data. As a result, there is an effect in that it is possible to search for the recommended path from the start point to the destination at high speed.

Detailed Description Text (214):
Further, according to the present invention, the path search index data or the path search hierarchical index data includes, for example, the data showing that the toll road should preferentially be selected, the data showing that the toll road should not preferentially be selected, and the data showing that the path leading to the specified facilities should preferentially be selected. In view of the priority data desired by the passenger, the path search index data searching means or the path search hierarchical index data searching means searches for the recommended path. As a result, there is an effect in that it is possible to search for the recommended path from the start point to the destination depending upon the road characteristic desired by the passenger at high speed only by switching of the index data.

Detailed Description Text (215):
Further, according to the present invention, the path search control means controls such that the path search index data searching means searches for the recommended path by using the path search index data and the path search network data depending upon the direction in which the own vehicle travels from the nodes at the both ends of the link including the current position of the own vehicle, selects the recommended path having the lower cost value from among the obtained recommended paths from the nodes at the both ends so as to avoid the U-turn as far as possible, and indicates the path to the passenger through the indicating means. As a result, there is an effect in that it is possible to search for the recommended path from the start point to the destination at high speed in view of the direction in which the vehicle travels.

Detailed Description Text (216):
Further, according to the present invention, the data of the recommended path which has been obtained is stored in the recommended path storage means, the path deviation detecting means detects deviation of the current position from the recommended path, and the path search control means controls such that the path search index data searching means searches for the path from the point where the own vehicle deviates from the recommended path to the destination or the original recommended path by using the data of the recommended path and the path search index data. Even when the own vehicle deviates from the recommended path, the path to the destination or the original recommended path is provided for the passenger as far as possible. As a result, there is an effect in that it is possible to search for the path from the position of the vehicle or the start point to the destination or the original recommended path at high speed in view of the direction in which the vehicle travels even when the vehicle deviates from the recommended path obtained by the previous search.

Detailed Description Text (217):
Further, according to the present invention, the data of the recommended path is stored in the recommended path storage means, the path search control means sets the point on the recommended path within the predetermined range from the current position of the own vehicle as the destination, and the alternative path searching means makes the path search by setting the cost of the recommended path higher and efficiently searches for the alternative path. As a result, there are effects in that it is possible to, when the traffic jam or the like is generated on the recommended path, search for the new recommended path to bypass the recommended path at high speed by setting the point on the recommended path as the destination and making the path search with higher cost of the recommended path, and indicate the new recommended path to the driver.

Detailed Description Text (218):
Further, according to the present invention, the data of the recommended path is stored in the recommended path storage means. By using the traffic information received by the traffic information receiving means, the dynamic path searching means sets the point on the recommended path within the predetermined range from the current position of the own vehicle as the destination to calculate the recommended path cost in which the dynamic traffic information is reflected and make the path search. As a result, there are effects in that it is possible to search for the recommended path

corresponding to the dynamic traffic situation such as traffic jam and regulation at high speed by setting the point on the recommended path as the destination and making the path search by using the cost in which the dynamic traffic information is reflected, and indicate the recommended path to the driver.

Detailed Description Text (219):
Further, according to the present invention, when the travel path deviates from the recommended path to the same destination the predetermined number of times or more, the index data changing means changes the path search index data such that the vehicle passes along the travel path, and the changed data is stored in the path search index data storage means. As a result, there are effects in that it is possible to store the alternative path, for example, chosen according to the driver's taste or frequently used to pass in the recommended path, and provide the alternative path for the passenger.

Detailed Description Text (220):
Further, according to the present invention, the path search control means makes the path search from the plurality of destination representative points selected from among the road network data to all the links in the network data, and the result of path search is stored in the path search control means. Further, the path search control means selects the destination representative point closest to the destination set by the setting means, searches the result of path search for selection of the recommended path until the own vehicle approaches the point at the predetermined distance from the destination, and sequentially reads the recommended path leading to the destination representative point. Further, the indicating means indicates the recommended path leading to the destination set by the setting means from the start point. As a result, there are effects in that it is possible to set the memory size smaller, and search for the recommended path at high speed.

Detailed Description Text (221):
Further, according to the present invention, the road on the road network data is divided into the plurality of groups which are geographically in close to each other. If there is the destination representative point providing completely the same optimal path in the group, the same path search index data to the destination representative point is representatively stored in the path search index data storage means. If there are the plurality of destination representative points having the small difference between the optimal paths in the group, the difference in optimal path data is calculated between the destination representative points. The path search index data in which one optimal path to the destination representative point is expressed by the differential data to the other optimal path is stored in the path search index data storage means. As a result, there are effects in that it is possible to set the memory size smaller, and search for the recommended path at high speed.

Detailed Description Text (222):
Further, according to the present invention, one case where the destination representative point is located inside the group is distinguished from the other case where located outside the group. The path search index data about the path to the destination representative point is divided to be stored in the path search index data storage means. As a result, there are effects in that it is possible to set the memory size smaller, and search for the recommended path at high speed.

Detailed Description Text (223):
Further, according to the present invention, in the path search index data storage means is stored the higher-hierarchy level road network data for retrieving the long-distance destination point obtained by selecting the many roads included in the optimal path leading to the destination representative point at the long distance from among the data of the optimal path obtained by the previous search. As a result, there is an effect in that it is possible to search for the recommended path at high speed by using the higher-hierarchy level road network data.

Detailed Description Text (224):
Further, according to the present invention, there is provided the path search method including the steps of searching for the recommended path from the link closest to the current position of the own vehicle to the main link closest to the destination by using the network data about the road attribute and the connection of the main road

and the path search index data serving as the path information between the link and the node, and indicating the recommended path obtained by the search to the passenger. As a result, there is an effect in that it is possible to search for the recommended path at high speed.

Detailed Description Text (225):
Further, according to the present invention, one search method of searching for the recommended path from the link closest to the current position of the own vehicle to the main link closest to the destination by using the path search index data, and the other search method by using the path search road network data are selectively used depending upon the distance to the destination. As a result, there are effects in that it is possible to efficiently search for the recommended path at high speed, and indicate the recommended path to the passenger.

Detailed Description Text (226):
Further, according to the present invention, each time the predetermined condition is met during the search for the recommended path to the destination, the recommended path obtained during the search for the recommended path is provided for the passenger whenever necessary. As a result, there is an effect in that it is possible to efficiently and rapidly indicate the recommended path to the passenger.

Detailed Description Text (227):
Further, according to the present invention, when the distance from the terminal link of the recommended path to the destination is equal to or less than the predetermined distance, the search is made for the recommended path by using the path search road network data. As a result, there is an effect in that it is possible to efficiently search for the recommended path.

CLAIMS:

1. An on-vehicle path guide apparatus comprising:

current position detecting means for detecting a current position of an own vehicle;

setting means for setting a destination;

path search road network data storage means in which network data showing a road attribute and connection of a road is stored;

path search index data storage means for storing path information about whether or not each link connection to a node may reach other nodes as path search index data;

path search index data searching means for searching for and obtaining a recommended path from a node near the current position to a node near the destination by selecting a link that may reach the node near the destination based on path search road network data and the path search index data; and

path search control means for controlling the operations of the current position detecting means, the setting means, the path search road network data storage means, and the path search index data searching means, and providing to a passenger the obtained recommended path through an indicating means.

2. An on-vehicle path guide apparatus according to claim 1,

wherein, even while the path search index data searching means is searching for a recommended path to the destination, the path search control means indicates the recommend path obtained by the search through the indicating means each time a predetermined condition is met.

3. An on-vehicle path guide apparatus according to claim 1,

wherein, when a distance from a terminal link of the recommended path obtained by a search made by the path search index data searching means to the destination is equal to or less than a predetermined distance, the path search control means selects the path search road network data searching means to search for the recommended path to

the destination by using path search road network data.

4. An on-vehicle path guide apparatus according to claim 1,

further comprising a means for storing path search hierarchical index data in which path search hierarchical index data including hierarchical path information to each area is stored; and

path search hierarchical index data searching means for searching for and obtaining a recommended path from a main road closest to the current position of the own vehicle to a main road closest to the destination by using the path search hierarchical index data.

7. An on-vehicle path guide apparatus according to claim 1,

wherein the path search control means controls such that the path search index data searching means searches for the recommended path by using path search index data and path search network data depending upon a direction in which an own vehicle travels from nodes at both ends of a link including the current position of the own vehicle, and selects a recommended path having a lower cost value from among the obtained recommended paths from the nodes at the both ends so as to indicate the recommended path through the indicating means.

8. An on-vehicle path guide apparatus according to claim 1, further comprising:

recommended path storage means in which data of the recommended path obtained by a search is stored; and

path deviation detecting means for detecting that the current position of the own vehicle detected by the current position detecting means deviates from the recommended path,

wherein the path search control means selects the path search index data searching means to search for a path from a point where the own vehicle deviates from any one of the recommended path to the destination and the original recommended path by using data of the recommended path and path search index data.

9. An on-vehicle path guide apparatus according to claim 1, further comprising:

recommended path storage means in which data of a recommended path is stored; and

alternative path searching means for setting a point on the recommended path within a predetermined range from the current position of the own vehicle as a destination, and for searching an alternative path by setting a cost, indicating a degree of difficultly in driving, that is higher than a cost for other path.

10. An on-vehicle path guide apparatus according to claim 1, further comprising:

recommended path storage means in which data of a recommended path is stored;

traffic information receiving means for receiving traffic information; and

dynamic path searching means for setting a point on the recommended path within a predetermined range from the current position of the own vehicle as a destination to calculate a recommended path cost in which the traffic information is reflected, and searching for the recommended path.

11. An on-vehicle path guide apparatus according to claim 1, further comprising:

recommended path storage means in which data of a recommended path is stored;

path deviation detecting means for detecting that the current position of the own vehicle deviates from the recommended path;

deviation travel path storage means in which a travel path after the own vehicle

deviates from the recommended path and a destination are stored; and

index data changing means for changing path search index data such that the vehicle passes along the travel path when the travel path deviates from the recommended path to the same destination the predetermined number of times or more, and storing the changed data in path search index data storage means.

12. An on-vehicle path guide apparatus according to claim 1,

wherein the path search control means makes a path search from a plurality of destination representative points selected from among road network data stored in the path search road network data storage means to all links in the network data storage means to all links in the network data so as to store a result of path search, selects a destination representative point closest to a destination set by the setting means, searches the result of path search for selection of a recommended path until the own vehicle approaches a point at a predetermined distance from the destination, sequentially reads a recommended path leading to the destination representative point, and controls the indicating means to indicate the recommended path leading to the destination set by the setting means from a start point.

13. An on-vehicle path guide apparatus according to claim 1,

wherein a road described by road network data is divided into a plurality of groups which are geographically in close proximity to each other, if there is a destination representative point providing completely the same optimal path in the group, the same path search index data to the destination representative point being representatively stored in the path search index data storage means, if there are a plurality of destination representative points having a small difference between the optimal paths in the group, a difference in optimal path data being calculated between the destination representative points, and path search index data in which on optimal path to the destination representative point is expressed by differential data to the other optimal path being stored in the patch search index data storage means.

14. An on-vehicle path guide apparatus according to claim 13, wherein said path search index data storage means stores path search index data for paths to said destination representative points that are divided corresponding to following two cases (a) and (b):

(a) said destination representative points are located in said group; and

(b) said destination representative points are located in outside of said group.

15. An on-vehicle path guide apparatus according to claim 1,

wherein in the path search index data storage means is stored higher-hierarchy level road network data for retrieving a long-distance destination point obtained by selecting many roads included in an optimal path leading to a destination representative point at a long distance from among data of an optimal path obtained by a previous search, and the indicating means indicating a wide-area map obtained depending upon the higher-hierarchy level road network data.

16. An on-vehicle path guide apparatus comprising: current position detecting means for detecting a current position of an own vehicle;

path search road network data storage means in which network data showing a road attribute and connection of a road is stored;

path search index data storage means in which path information between nodes is stored as path search index data;

path search index data searching means for searching for and obtaining a recommended path from a node near the current position to a node near the destination by using path search road network data and the path search index; and

path search control means for controlling the operations of the current position

detecting means, the setting means, the path search road network data storage means and the path search index data searching means, and providing to a passenger the obtained recommended path through an indicating means,

wherein path information to each area encompassing said nodes is stored in the form of path search index data in the path search index data storage means, and the path search index data searching means searches for a recommended path from a main road in the vicinity of the current position of the own vehicle to an area in which the destination is located by using the path search index data.

17. A path search method comprising the steps of:

detecting a current position of an own vehicle;

setting a destination;

searching for a recommended path from a node near the current position of the own vehicle to a node near the destination by selecting a link that may reach the node near the destination by using network data about a road attribute and connection of a main road and path search index data as path information showing whether or not each link connected to a node may reach other nodes; and

indicating the recommended path obtained by the search to a passenger.

18. A path search method according to claim 17,

wherein a search method of searching for the recommended path from the node closest to the current position of the own vehicle to the main node link closest to the destination is selected depending upon a distance to the destination, by using any one of the path search index data and a search method for searching by using path search road network data.

19. A path search method according to claim 17,

wherein, each time a predetermined condition is met during a search for a recommended path to the destination, the recommended path obtained during the search for the recommended path is provided for a passenger whenever necessary.

20. A p path search method according to claim 17,

wherein, when a distance from a terminal link of the recommended path to the destination is equal to or less than a predetermined distance, a search is made for the recommended path by using path search road network data.

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DOCUMENT-IDENTIFIER: US 6505117 B1
TITLE: Method for navigating an object

Abstract Text (1):
A method for navigating an object, such as a radio telephone, from a starting point to a destination along traffic routes that are contained in an electronically stored traffic route map and are in the form of routing points. The routing points are assigned routing values which, starting from the destination, either only increase or only decrease as the distance from the destination grows larger. The object is then navigated by following a path of routing values which only decrease or only increase.

Brief Summary Text (3):
The invention relates to a method for navigating an object in accordance with the preamble of Patent claim 1. In said method, the object is navigated starting from a starting point to a destination along traffic routes which are contained in an electronically stored traffic route map.

Brief Summary Text (5):
Routing or navigation systems are used, for example, to direct a driver with his motor vehicle to his destination in the best way possible. Different navigation systems differ in this respect. Those of the first generation are autonomous. They merely have digitized traffic routes or road maps on CD-ROM and do not have a connection to traffic information services or service providers. For this reason, their route calculations cannot be optimized with respect to the current traffic conditions. Other disadvantageous factors are the relative speed with which the street maps become out of date and the necessity of having to obtain the appropriate data carriers whenever one wishes to drive to new, more remote regions.

Brief Summary Text (6):
In navigation systems with so-called "off-board" routing, the calculation of the route is exported to a service provider. Thus, for example, a driver has the route dynamically transmitted to him after he has input his destination. The exporting of the calculation of the route and of the data material required for it has a number of advantages. Thanks to the service provider's access to information from an extremely wide variety of sources which he can coordinate and interconnect centrally, the service provider is able to include immediately in the calculation of the routes current traffic reports, congestion forecasts, information on road works and the weather etc. In addition, the service provider can keep his data stock (digitized road maps, information on hotels, sights, public buildings etc.) more up to date and has access to relatively large quantities of data and more computing power than terminals (as cheap as possible). In this way, the driver can be guided on a route which is dynamically optimized to the respective current peripheral conditions. In addition, the procurement of new updated CD-ROMs is dispensed with. The traffic processes are thus optimized and traffic flow is made more efficient, reliable and less damaging to the environment.

Brief Summary Text (7):
It has proven a disadvantage with the two methods described above that, in order to calculate the route from the starting point to the destination, a relatively large amount of data management has to take place, and thus a large computing capacity and computing time are required.

Brief Summary Text (12):
A method according to the invention is distinguished by the fact that the traffic routes contained in the electronically stored traffic route map are provided with routing points. These routing points contain not only information, for example in the form of a vector, on their actual geographic position (length, width) but also information on the course (for example course of the roads) lying in their vicinity, and the directions along which it is possible to navigate or drive. The routing points thus greatly facilitate the navigation and reduce the computational work which it requires.

Brief Summary Text (13):
According to a very advantageous development of the invention, the routing points are assigned routing values which, starting from the destination, either only increase or only decrease as the distance from said destination grows larger, the object being navigated using the routing values which only decrease or only increase.

Brief Summary Text (14):
The routes are calculated according to the inventive method starting from the destination in the manner, as it were, of a propagating wave with routing values.

Brief Summary Text (15):
In the process, the destination is assigned, for example, the routing value 1, while all the routing points which, viewed in the direction in which the route runs, are directly adjacent are assigned the routing value 2. The last-mentioned routing points which are directly adjacent in the direction in which the route runs are then assigned the routing value 3, and the destination is now eliminated out etc. The routing values can thus be used to guide the object starting from any position in the traffic route map. To do this, the closest routing point with the lowest routing value is used as the direction indicator because this point lies closest to the destination. The method could in principle also be implemented in such a way that it is started with a relatively high routing value at the destination, which then decreases to lower values. In this case, the navigation would take place from the starting point to the destination in the direction of increasing routing values.

Brief Summary Text (16):
The provision of the routing points with the routing values which either only increase or only decrease can be implemented relatively easily and quickly with the result that the route can be calculated in a short time and with only a small amount of computing power. The data record which is necessary for the navigation itself after the route has been created is, furthermore, relatively small, with the result that its management also requires only a small amount of computing capacity and storage capacity.

Brief Summary Text (17):
The method according to the invention can therefore also be implemented advantageously in first-generation navigation systems, provided that the traffic route maps stored on the CD-ROMs are provided with routing points. The routes can be calculated relatively quickly and with little computing power, with the result that relatively cheap terminals can be used. This applies also with respect to the fact that the data record calculated for navigation is relatively small, with the result that it also requires only a small amount of storage capacity.

Brief Summary Text (18):
However, owing to this relatively small data record which represents the calculated route, it is also possible to apply the method according to the invention advantageously even if the "off-board" routing which has already been described at the beginning, in which the route is calculated by the service provider, is carried out. In this case, the calculated route must be transmitted from the service provider to the navigation system of the object which is to be navigated, which can now be carried out relatively easily, for example over a telephone link, owing to the small amount of data for the calculated route.

Brief Summary Text (19):
Apart from digital voice transmission, mobile radio also provides various possible types of data transmission, and it is now available with virtual complete coverage.

Thus, the data which relate to the navigation, in this case the route calculated by the service provider, can be transmitted to the customer using an existing telephone by means of, for example, the GSM short message service SMS. Because the amount of data to be transmitted is relatively small, calling the calculated route from the service provider to the customer does not constitute a considerable cost factor, especially since the transmission of data does not require a continuous data link. The use of the method according to the invention could thus be attractive even if parts of its execution take place at the service provider end.

Brief Summary Text (20):
The method according to the invention can in principle be implemented to navigate any desired objects along traffic routes. As already mentioned, the objects can be motor vehicles which are capable of detecting their actual geographic position, for example using a GPS receiver which is carried along.

Brief Summary Text (21):
However, the objects of the type in question may also be mobile phones themselves if they are capable of detecting their actual geographic position, for example by surveying their position using a plurality of surrounding base stations. In this case also, the route calculated in advance between the starting point and the destination could be transmitted over the radiotelephone link from a service provider to the mobile phone and stored there, because the data record describing the route is relatively small, and thus can easily be buffered in the mobile phone. The user of the mobile phone could then carry out navigation in, for example, an optimum way using the display device of the mobile phone.

Brief Summary Text (23):
If the routing points are allocated by a service provider, routing points may also be allocated temporarily, for example in the vicinity of diversions, owing to road works, accidents etc. which are set up for a limited period of time. The assignment of the routing values to the routing points is preferably made on the basis of route elements, which means that initially the routing points are provided with routing values only along part of the route lying between the destination and starting point, and then the next part of the route from the point lying closest to the destination to the starting point etc. In this way it is possible to ensure that, from any desired point on the traffic route map, a route element with the desired descending or rising sequence of routing values is always obtained in the direction of the destination.

Brief Summary Text (25):
The type of traffic route itself is determined in the vicinity of a respective routing point by means of a multidimensional vector which comprises not only branching and road-use possibilities in the respective directions but also contains information on the respective street name, the routing value (the navigation information) which is relevant in the direction of the destination and the actual geographic coordinates of the routing point. Such a vector ensures that the object will be routed reliably.

Brief Summary Text (26):
According to one development of the present invention, the size of the map excerpt is determined by the positions of the starting point and destination. The map excerpt comprises here not only the relatively close vicinity of the starting point and of the destination but also a respective region between the two points which is, for example, in the form of a tube and which can be implemented with a greater or lesser width. The width of this tube-like region and the size of the regions respectively surrounding the starting point and destination can be preset or selected by the user of the navigation system. However, the routing points have to be provided with the routing values only for the selected regions, and not for the entire traffic map, with the result that this is also a reason why only a relatively short time and small amount of computing power are required to generate the navigation route.

Brief Summary Text (27):
According to another development of the invention, when the object leaves the map excerpt, a new map excerpt is, for example called automatically, in which the routing values are assigned to the routing points with respect to the old destination and a new or instantaneous starting point, with the result that it is now also possible once more to navigate the object in the direction of the destination.

Brief Summary Text (28):
As an alternative to this, when the object leaves the map excerpt, a compass navigation back to the old map excerpt may also take place. When the object enters said old map excerpt, it is then possible to navigate again by reference to the routing values.

Drawing Description Text (16):
FIG. 14 shows a program flowchart for a navigation;

Drawing Description Text (17):
FIG. 15 shows the outputting of an item of navigation information;

Drawing Description Text (26):
FIG. 24 shows a program flowchart for navigation with possible errors;

Drawing Description Text (30):
FIG. 28 shows a program flowchart for compass navigation;

Detailed Description Text (2):
The surroundings of the car driver have changed in the last few years. Nowadays, in many new vehicles stand-alone navigation systems can be found next to the car radio. The owner of the vehicle often also has a mobile phone with him. However, using these newly added systems while driving has now been found to constitute a risk factor for road users. For this reason, in order to increase driving safety, the mobile phone can, for example, be permanently installed with a hands-free system and connected to the radio. Thus, the driver's concentration is distracted virtually no more than by a conversation with the occupants of the vehicle, because he neither has to look for the mobile phone nor pick it up in his hand. Voice recognition systems which permit all user functions such as the dialling of numbers, acceptance of an incoming call etc. are already available.

Detailed Description Text (5):
The configurable or dynamic user interface UI is part of a navigation system which, in the present case, is intended to operate exclusively with GPS (Global Positioning System) or DGPS (Differential GPS). As is the case in already existing navigation systems, GPS is only. one component of the position-finding system. Wheel-mounted signal transmitters and an electronic compass can supplement the position-finding system.

Detailed Description Text (6):
The navigation system which has been developed guides the driver of the vehicle using the previously recorded map material to any desired destination by means of suitable audio-visual instructions. The navigation instructions are communicated by means of TCP/IP (Transmission Control Protocol/Internet Proto-col: a combination of protocols for transmitting data between data processing environments) to another process which is running in parallel and which manages the audio-visual output units. In selecting the current driving instruction, the program is capable of taking into account the reaction of the driver to the last driving instruction generated, ensuring that the driver is continuously guided to the destination despite possible incorrect actions taken on his part.

Detailed Description Text (7):
In addition, the navigation system was conceived in such a way that the driver of the vehicle can be directed to the destination with minimum expenditure in terms of data. As a result, it is possible to carry out the calculation of the routes, i.e. the generation of the digital map and the relevant navigation information, in a decentralized fashion at a mobile-radio service provider. Thus, the need to provide local computing power in the vehicle to determine the route and a storage medium such as a CD-ROM for the road map is eliminated. For navigation, the hardware requirements are reduced to a GPS receiver and a mobile radio terminal. The user interface UI performs the function of connecting the hardware components and the interface to the user.

Detailed Description Text (8):

The centrally stored general map can be maintained and updated. In addition, the service provider can make use once more of information relating to the route (traffic jams and forecasts of traffic jams, information on roadworks and road closures etc.) and take this information into account in the calculation of the route. The respective excerpt of the map is transmitted to the customer's telephone by the mobile-radio provider after the calculation, for example using the GSM (Global System for Mobile Communications) (Short Message Service) SMS. The quantity of data for this excerpt should be as small as possible in order to minimize the transmission time, and thus the customer's costs. However, the information content of the map must be sufficient for problem-free navigation, which also allows for possible incorrect actions taken by the driver.

Detailed Description Text (9):
So that even persons without background knowledge can easily generate the map material, a simple method for inputting and storing the data required for navigation has been developed.

Detailed Description Text (11):
Connected applications 1, . . . N, such as the NAV navigation system which has been developed with a GPS receiver for supplying geographic position information data or with programs for making available traffic information, make their functions available to the user interface UI, but do not communicate with the user. They therefore do not receive any direct inputs or pass on any results directly to the user. The communication with the user is carried out via the user interface UI and its input and output devices. The control is menu-prompted and intuitive, the dialogues are easy to understand and free of contradictions. The inputs can be made by means of voice or keys in any situation.

Detailed Description Text (15):
The structural part 5 passes on the enquiries from the applications 1, . . . , NAV, . . . , N to the relevant scaleable part 6. In addition, a database 8, in which all the equipment-specific and user-specific data are stored, is connected to said scaleable part 6. This structural part is composed essentially of a task controller (TC) 5. The task controller 5 is also connected to a mobile phone 9, via which a radio link 10 to a service provider is established. Via this radio link, the data which relate to the navigation are transmitted to the customer using the existing telephone 9 and the GSM short message service SMS. It is preferable here to transmit the required data once. These data contain, firstly, the map excerpt which is required for navigation, including relevant secondary roads which permit the driver to be guided continuously to the destination even if he takes incorrect actions. Secondly, supplied together with this map is information with which the navigation program, with the name "route" can generate the appropriate instructions for the driver and thus guide him to the destination.

Detailed Description Text (16):
If the driver leaves this map excerpt which is provided in the car, the user can choose between two navigation alternatives. Firstly, it is possible to request a new map which corresponds to the current area. Secondly, he can be directed back into the known area by means of a compass navigation procedure which indicates the direction to be taken, supported by the GPS position. In the latter case, the customer does not need to request a new map and he does not incur any further costs.

Detailed Description Text (17):
Within the scope of the present invention, by virtue of two files there are two methods of operation of the "route" navigation program which allows the user to choose between independent operation of the program --a so-called stand-alone mode--or communication with the program "route_server". FIG. 2 shows an overview of this.

Detailed Description Text (18):
The stand-alone operating mode is to be understood as the integration of functions F1, F2 for loading the map and for calculating the route into the navigation program. It is thus not necessary to exchange data with the service provider because the "route" program can access the map material and the route-calculation function directly.

Detailed Description Text (20):

For the calculation of the route and later navigation it is necessary to know the area of roads which are to be travelled on, together with the area's junctions and intersections and the traffic regulations. The respective direction instructions have to be placed in numerical relationships. In addition, the geographic position information must be stored.

Detailed Description Text (31):
During the navigation, the instruction to turn off to the right must be given earlier than on a normal road, specifically at the start of the slowing-down lane at the latest. Instructions relating to travelling straight ahead, possibly for long periods, should be omitted on motorways. For these reasons, and further reason explained later, the presence of a motorway must be clearly visible on the map. In order to achieve this, free variable is used for turning off to the left, which, for German maps, would always be with 0. This is equivalent to the inverted, right-hand point. This is impossible on normal roads because each point can occur only once. It is thus possible to characterize a motorway without an additional variable. The programming operations for FIG. 7 can be found in Table 5. By analogy with one-way streets, the directions in which it is not permitted to drive should also be made negative here. The points which are not known for this example and which therefore lie outside the illustration are again replaced by an x.

Detailed Description Text (32):
A further particular feature is, as already indicated, the approach slipway. Here, it is not uncommon for drivers to take incorrect actions. In addition, there is an instruction to turn off to the right if, in the conventional sense, the exit has been programmed "at the rear", which makes no sense. It would be impossible to locate the coordinates of the "intersection" of the motorway approach slipway because they would have been recorded at the start of the slowing-down lane. For this reason, the point 40 cannot be programmed at point 41, for example. However, at point 41 during the navigation it must be known which exit is to be taken. In order to achieve this, the variable for the entry to the motorway indicates the closest, reachable exit in positive terms. For this purpose, the number 33 must be programmed at the "rear" of point 41. On the other hand, point 33 can only point back to one point although it is possible to program two points (32 and 41). It is agreed that it points back to point 32 in negative terms, it being theoretically possible to program point 41.

Detailed Description Text (34):
FIG. 9 shows the example of an idealized road map k. The numbers of the roads S, on which details will be given below, are given after the street names in brackets. The vector of the point P or routing point contains not only the surrounding points which have already been described but also the number of the associated street name and the two-dimensional GPS coordinates, i.e. the degrees of longitude and latitude of the point. If a street name has not been entered for this point, because it constitutes, for example, a point outside the map and should therefore not be travelled along, a -1 is entered here as a designation for the street.

Detailed Description Text (49):
If the input "Herner Street" is then made in response to the request for the street name from point 9 to point 10, this street is assigned the number 2. The street name from point 11 to point 14 is then interrogated, because point 12 and point 13 are only auxiliary points for navigation and do not entail a change of the street name.

Detailed Description Text (51):
A number of practical instructions for the generation of the digital map will be given below. At the start of the allocation of points, the process should not be begun directly with 1 as the first number because usually there are also points at the starting point--which will probably be programmed first later. As far as possible the points should be input in a closed fashion because the inputting operation when allocating the street names can be terminated quickly using "return", and the map also becomes easier to read. After the assignment of points for a road has been finished, a number of points should be left free because, for example, secondary roads at the periphery are frequently forgotten, or roads are not entered on the map, and numbers can thus be inserted logically without difficulty. Visibly separate areas on the map by means of high numbers: points can thus more easily be found again when inputting the road names, during later storage of the coordinates or during navigation. A

simulation file of a road element which is to be travelled along can thus be generated. It is thus possible to carry out a first navigation locally on the computer. Possible errors on the map can thus be found more conveniently.

Detailed Description Text (55):
In order to assign the points to the respective GPS coordinates, a program with the name "save_map" is used. After the program has been started, the map must be loaded. Here, either a file name can be entered or the preset name is accepted using "Return". The first point which is to be stored must then be entered. Here, using `1` a GPS file which has already been registered can additionally be loaded. Then all the points which are still to be stored are listed. Here, the programmer can select which point he would like to drive to first. The figure below shows the layout of the screen after both the files have been loaded. The presettings of the file names are transferred with "Return", and point 5 will be registered next.

Detailed Description Text (56):
The following figure shows the screen mask of the program for the storage of point 5. Because the identical GPS position is registered for all the points of an intersection, the GPS coordinates of the points 6, 35, 36 are also registered after the point 5 has been stored.

Detailed Description Text (57):
The upper part of the screen mask of the following figure shows general information of the GPS receiver. For example, the statusment "Fix quality: DGPS, satellites being tracked: 6" shows that a DGPS measurement with six satellites is being carried out. The currently measured position is output under this. In addition, the speed and the orientation with respect to north which are determined are represented. The parameters PDOP, HDOP and VDOP which are supplied by the GPS receiver give an indication of the accuracy of the current position measurement. The extreme values are output for the tolerances indicated below. The smaller the respective value, the more precise is the current measurement.

Detailed Description Text (58):
The lower part of the screen mask shows a schematic layout of the intersection. During the registering process, the programmer can thus reassure himself that he assigns the correct points when storing the coordinates. In this case, the intersection has to be approached via point 4, Meesmann Street. This is relevant for determining the next points to be stored. After the GPS position has been transferred, the program detects the direction of travel and from the information in the map it can automatically propose storage of the coordinates of the next points which will be approached. The result of this is that the programmer does not need to enter in advance each point which is to be stored.

Detailed Description Text (60):
The automatic direction detection can be bypassed using the arrow keys. If the GPS position is transferred, for example, using the left-hand arrow key, the program assumes that the vehicle has turned off to the left and the points on the intersection should be registered from point 34.

Detailed Description Text (63):
As has been described previously, a map excerpt with navigation information is transmitted to the vehicle via SMS, for example. If a map of an entire country were provided, this would be too extensive to send via SMS. An excerpt should be formed beforehand and this can be used to guide the driver from his current location to the destination.

Detailed Description Text (65):
The navigation system which, inter alia, executes the "route" program should guide the driver of the vehicle to any desired destination by means of suitable audio-visual instructions or driving instructions. The instruction is to be understood firstly as an instruction to carry out an action such as turning off to the left or to the right or to travel straight ahead, and secondly as the transmission of status information such as "Your route has been calculated" or "You have reached your destination". For the voice outputting of the instruction, a complete sentence is generated which contains not only the direction in which to travel but also the street name and the

distance from the action. A possible instruction could be, for example, "Please turn off to the right into Meesmann Street in 250 metres."

Detailed Description Text (67):
In order to avoid driving errors and to make orientation easier, up to three instructions with different distances from the TC 5 are sent per action. The configuration of the distances will also be described. The user inputs only the destination because the starting point of the navigation is the currently measured position. The destination is initially a road in the registered map.

Detailed Description Text (68):
If the "route" program is started from TC 5, that is to say a navigation is desired--initially a number of initialization processes of the software and hardware are necessary. If the initialization processes have run successfully, the starting point and the destination must be known to calculate the route. The starting point is determined by means of the current position of the vehicle. Because the destination is input by the user, the "route" program must request it from the TC 5, which then communicates with the respective processes. The starting and destination information is then communicated to the server which performs the route calculation, as is described below.

Detailed Description Text (70):
The actual navigation during which the driving instructions are determined and communicated to the TC 5 for outputting then begins. In addition, an error which may occur is passed on directly to the TC 5.

Detailed Description Text (71):
An overview of the individual initialization steps which have to be carried out by the start of the actual navigation is given in FIG. 10.

Detailed Description Text (72):
All the settings of the values which are relevant for the program and the navigation are loaded from a configuration file and can thus easily be changed by the user. Here, it is possible, for example, to choose between the outputting languages of English or German and to change the settings of the serial interface. Before the configuration file is read, all the variables are set with a predefined value in order to avoid incorrect configuration.

Detailed Description Text (73):
After storage has been reserved, the serial interface is opened. In order to ensure error-free initialization and checking of the readiness to receive of the GPS receiver, the appropriate NMEA data are read and evaluated before the route is calculated. In the GGA data record it is possible to check whether the GPS receiver is supplied with correction data via RDS.

Detailed Description Text (74):
In order to calculate the route, the known Lee algorithm can be used, said algorithm being applied, inter alia, in layout programs for printed circuit boards. In such a case, a wave with so-called distance increments or routing values W is propagated from the destination. The destination DEST receives the routing value 1, all the surrounding points P receive the routing value 2 etc. FIG. 11 shows the assignment of the routing values W to the routing points P of the exemplary map K according to FIG. 9. The respective routing value W is noted after the routing points P.

Detailed Description Text (75):
These routing values can be used to guide a vehicle to the destination from any position on the map. To do this, the surrounding routing point with the lowest routing value is used as direction indicator, because the latter is closest to the destination. If the vehicle is located, for example, at the starting point A which is entered on FIG. 11, the point 17 is firstly driven to, because this has the lower routing value (4). Then, the points 4 (3), 5 (2) and finally the destination point 36 (1) are headed for. At the starting point B, the destination is reached via the points 13, 12, 11, 2, 34 and 5.

Detailed Description Text (76):

A special case occurs at starting point C: after the points 26, 21 and 20 have been passed through, the points 37 and 19 have the same distance factor. Because, according to the route calculation, both routes are thus at the same distance from the destination, it is possible, for example, to select the instruction to drive straight ahead because it is unnecessary for the driver to turn off the road.

Detailed Description Text (77):
In the case of one-way streets and motorways, a separate consideration during the allocation of distance increments is necessary. Because the one-way street can only be travelled along in one direction, this must be taken into account in the distance increments. Increments of the wave must be allocated in the opposite direction to the permitted direction of travel of the one-way street because the wave is started from the destination, and the section of the route is thus travelled along in the opposite direction to the direction of travel, and thus of the later navigation. A one-way street with the respective distance increments is illustrated in FIG. 12.

Detailed Description Text (80):
A similar procedure is adopted for motorways. FIG. 13 shows two route calculations. In the upper half there is the destination for vehicle 1, and for vehicle 2 on the left-hand side. The wave of the routing values has therefore propagated from point 10; for this reason, this point has the routing value 1 here. The point 11 receives the routing value 2 as a point lying in the vicinity of 10. The routing values of points 12, 13 and 14 are allocated in a corresponding way. In addition, during the allocation of the routing values for the motorway points--in particular in the case of point 10 here--careful attention must be paid as to whether a different, unknown point has an "at the rear" reference to the motorway. Here, point 15 points to point 10. For this reason, during the calculation of the route it is checked whether the point which allocates the next routing value for its surrounding points is a motorway. This can be detected from the absolute value of the same elements of the right-hand and left-hand variables.

Detailed Description Text (81):
If the vehicle 1 is going to reach point 12, it has the choice between driving straight ahead and turning off to the right. Because the increment for driving straight ahead is lower than the current one, the program will wish to guide the driver to the destination along the motorway.

Detailed Description Text (82):
If the vehicle 2 wished to reach the destination 1, it would have to use the motorway. This is also reflected in the routing values.

Detailed Description Text (83):
In the lower half, the destination 2 for the vehicle 3 is located underneath the expressway. Here, point 20 is selected as starting point of the wave. The routing values are allocated in a way analogous to the example above.

Detailed Description Text (84):
If the vehicle reaches point 32, the driver is requested to change to the slowing-down lane. Once this has taken place, the driver is directed straight ahead past the exit. Then, the instruction to turn off to the right is issued, after which the driver will reach his destination.

Detailed Description Text (85):
Because the destination will generally not be a point but rather a road and because there are a plurality of points located on this road, before the assignment of the routing values a route calculation will be carried out with each point on the road with respect to the starting point of the vehicle. The route calculations of the points are compared, and the point which lies closest to the staring position is accepted as destination location for the route calculation used later.

Detailed Description Text (86):
The exchange of data between the server and client will be described below, specifically for the method of operation of external calculation of the route, i.e. the exchange of data with a server. Firstly, the current position and the street name of the destination is communicated to the server in a file. In addition, an

identification number is also sent, and said number will also be located in the response. A sequence composed of the date and the time can be selected as a message identifier. In this way, the client, that is to say the "route" navigation program can determine whether the map received corresponds to the requested conditions. An exemplary file is given below 100198145312 5130.892090 712.524292 DEST

Detailed Description Text (88):
An attempt is then made to assign the starting position to one of the points. The point lying closest to the direct distance is accepted as the starting point. This point is required only to determine the destination. It is not relevant for navigation because the driver can be guided to the destination from any position on the map.

Detailed Description Text (89):
The exact destination, i.e. the point on the destination street which promises to be the best possible route to the starting point, is then determined. This destination is then used to perform the calculation of the route.

Detailed Description Text (91):
Firstly, the identification number which is identical to the request, the number of transferred points, the number of transferred street names, the starting point which has been determined and the number of the destination street are provided in the first line.

Detailed Description Text (92):
The following lines contain the information on the map and on the navigation. This line contains, in succession, the number of the point, its surrounding points (RIGHT, STRAIGHT, LEFT, BACK), the number of the street name associated with the point, the distance increment of the point (the navigation information) and the coordinates of the point.

Detailed Description Text (94):
During the navigation itself, various statuses are successively passed through in accordance with FIG. 14. Thus, at the start in Step S 1 it is necessary to determine the starting position, i.e. the street on which the vehicle is located, and the direction of travel.

Detailed Description Text (95):
Once the map-related starting position has been determined, the main navigation loop begins. The main loop of this navigation operation is shown in FIG. 14. Firstly, the point which is to be driven to (the next destination) is calculated in Step S 2, and the direction to be travelled in is calculated in Step S 3.

Detailed Description Text (98):
If the vehicle has turned off the road correctly, it is tested in Step S 9 whether the destination has been reached. If this is not the case, the next destination, and the distance to be travelled in, are determined at this point. If the destination has been reached, this is communicated with a special instruction and the navigation is terminated.

Detailed Description Text (99):
If the driver follows the driving instructions, keeping to the calculated route, it is the main loop shown in FIG. 14 which guides the driver to the destination. Points which are characteristic of incorrect actions are illustrated with numerals in the figure. These will be listed later.

Detailed Description Text (102):
Using the series HIMSELF=0, RIGHT=1, STRAIGHT=2, LEFT=3 and BACK=4, firstly the elements of one row of the map matrix are addressed, secondly the direction information can be stored using them. In addition, the element NODIR=5 is added for compass navigation. More details will be given on its meaning later.

Detailed Description Text (103):
In Table 9, the possible statuses of the navigation--that is to say the values which the pos.fwdarw.route_status variable can assume--are listed.

Detailed Description Text (104):
The statuses can be divided into five areas. The first area, the first three statuses, are passed through before the start of the journey. The following second area is concerned with the determination of the starting position and the outputting of the first instruction. The third area contains the statuses for the error-free navigation which is to be described below. The fourth area calls the functions which react to incorrect action by the driver. The fifth and last area is composed of just the terminating status, when the destination is reached.

Detailed Description Text (110):
In the case of compass navigation during which the driver is guided by means of an arrow, the single output "Please follow the arrow" indicates this to the driver.

Detailed Description Text (111):
When the driver. arrives at his destination or is about to arrive at his destination, the respective information "You have reached your destination" or "You will reach your destination in . . . metres" is output.

Detailed Description Text (113):
This navigation instruction which is present in ASCII format is transferred to another process running in parallel, the "Text to Speech" process (TTS) by Means of TCP-IP via the TC. This message which is composed in an HTML-like language (Hypertext Markup Language: A page writing language used on the WWW) is given below.

Detailed Description Text (114):
Information which is comprehensible to the TC is given in the header line. It contains a brief description (navigation), the command (DISPLAY) which is to be executed, in this case the output, the number of messages (1), the mode of the message (HTML) and the sender (NAV for navigation).

Detailed Description Text (119):
The GPS receiver supplies the global coordinates, i.e. the degrees of longitude and latitude, of the current position. These data made available in degrees with minutes and seconds as decimal places. In addition, the data contains the hemisphere reference for the degree of latitude--for example always N North for Europe--and the direction of the angle for the degree of longitude, W for West or E for East

Detailed Description Text (120):
In order to determine the distance, the format supplied by the GPS receiver is firstly converted into a sliding decimal point value and subsequently converted into radiant. Table 10 shows the position data supplied for two registered exemplary points and their converted values.

Detailed Description Text (126):
In order to create an initial condition at the start of the navigation, the position in the map, i.e. the street on which the vehicle is located, and the direction of travel of the vehicle must be determined. Because, as a rule, only the coordinates of the two end points are known for the streets, and no intermediate points have been registered, the actual course of the street is not known. It is assumed that the street is a line between the end points. The position of the vehicle will generally be next to this idealized line.

Detailed Description Text (127):
In order to determine on which street the vehicle is located, firstly all the streets located in the vicinity are searched through and it is checked whether the vehicle could be located on these streets. For this purpose, the length of the street and the distances between the end points of the street and the current GPS position are calculated. If just one calculated element is longer than the length of the street, the vehicle could not be located on this street. In FIG. 16, for example the distance AB is greater than the distance components between the vehicle and the end points of the street, that is to say, Ax and Bx.

Detailed Description Text (133):
In the meantime, instructions to the driver for three different distances d.sub.i will indicate the direction to be travelled in. For this purpose, the distance d(x) from

the point which is to be driven to is measured with each measured GPS position x, and compared with three predefined radii which should correspond to the distances of the instructions. The first instruction is given, for example, if the distance d(x) is smaller than a corresponding radius r.sub.1, and the first instruction has not yet been given. If the distance d(x) were greater than the radius r.sub.1, the system would wait until the vehicle enters the radius. FIG. 19 shows the radii and the instructions associated with them.

Detailed Description Text (138):
If the vehicle has arrived at the expected intersection, the current location of the vehicle, which is stored as the point in pos, corresponds to the expected point post. The next point which is to be driven to can then be registered in post, and the third instruction can be entered. In order to determine the actual direction which is being travelled in at the intersection, the system changes into the status FindDrivenDirection. This status will be described later.

Detailed Description Text (139):
In addition, it is necessary to check whether the destination and/or the street name entered at the start of the navigation has been reached. In this case, the respective instruction relating to whether the destination has been reached is output, and the system changes into the status ReachedDestination which indicates this.

Detailed Description Text (141):
The direction driven is determined using the orientation of the movement of the vehicle with respect to the North Pole, calculated using the GPS receiver. This orientation is stored when the previously described radius r.sub.3 about the intersection is entered.

Detailed Description Text (146):
After turning off from the road, it is necessary to test--which is comparable with approaching the expected point--whether the destination has been reached. If this is not the case, the next point which is to be driven to, which is located "at the rear" of the actual point, can be stored in post. The system is then changed back to the status PrepareToSearchNewPosition. The detection of direction is illustrated schematically in FIG. 23.

Detailed Description Text (147):
This change between the approaching of the desired point and the determination of the current direction continues until the destination is reached. The instruction with the information that the destination has been reached is then output, and the program can be terminated.

Detailed Description Text (149):
Basically there are two errors which can occur during a navigation process. In FIG. 24, these are added to the program flow chart for error-free navigation from FIG. 14.

Detailed Description Text (150):
An error comprises turning off a road incorrectly at a junction or intersection. This is determined with the direction detection process (numeral 1). If the error is detected, it must firstly be tested whether the vehicle has left the area of the digital map transmitted from the server, i.e. whether the driver has driven beyond the boundary of the map. If this is not the case, a new route, which leads the driver, "as well as possible" to the existing route or to the destination, can be calculated. The calculation of this alternative route will be described below.

Detailed Description Text (151):
In addition, it may be the case that the point which has been found does not correspond to the expected destination or the intersection. This error situation is detected at numeral 2 in the program flow chart. It may have various causes: The direction detection was incorrect, and an adjacent point of the last intersection passed was therefore found. A point of the last intersection passed is found because the vehicle has turned. Points which bear a relationship to the current position are found. This can have various causes: firstly, measuring errors may have occurred, secondly the vehicle may be located in the vicinity of the points which are found, but not have any direct connection to them. This often occurs when travelling on motorways

because the points of the roads which cross over may be located very close to the motorway. In addition, it is possible for the vehicle to be actually located on the position determined on the map. This can be due to missing position information as a result of defective GPS position data or an imprecise map or the fact that a street which does not exist on the map has been travelled along in the meantime.

Detailed Description Text (153):
If the vehicle has departed from the calculated "optimum" route, it can no longer be guided by means of the routing points calculated by the server. For this reason, an attempt is made, by way of the same principle which was previously applied in the calculation of the route, to find a way back to the calculated route. However, the requirements for the calculation are reversed: the destination-the optimum route-is not known as a point. For this reason, the origin of the wave of the Lee. algorithm cannot be the destination. A wave-in the example the points 36 and 40-is started, as shown in FIG. 25 from the intersection which is the next reached, from each point branching off from said intersection. This is continued until the wave meets routing values which are no longer rising. In this way, it is possible to guide the vehicle to the destination again. In the example, for the wave at point 40 with the fifth routing value, the original routing value is identical to the corresponding value of the fourth increment. For this reason, an error-free navigation can take place again starting from here.

Detailed Description Text (155):
After a result has been found in all the directions in which it is possible to travel, the direction with the smallest distance from the destination is stored in the variable dir. In this case dir=STRAIGHT is set.

Detailed Description Text (156):
Then, as in the case of incorrect navigation, the system waits until the intersection is reached and the driver has turned off the road.

Detailed Description Text (158):
If the vehicle makes a correct turn at an intersection, in accordance also with the routing values supplied by the server, the program detects that error-free navigation is possible again.

Detailed Description Text (159):
During the calculation it is possible that no direction leads to the destination, or that the detour is too long. In order to prohibit long detours with the instruction "please turn round", a value has been introduced which stops the emitted wave of directions when a threshold value is exceeded. This value can be set individually.

Detailed Description Text (160):
With regard to the reaction to possible errors, the case of incorrect turning off from a road will be considered. After drive_alternative is set to TRUE, and the status of the navigation has changed to DrivingAlternative, it is necessary to check whether the vehicle is located outside the map. If the vehicle has driven beyond the boundary of the map, the system changes to the compass navigation described earlier. FIG. 26 clarifies this using a program flow chart.

Detailed Description Text (161):
If the vehicle is located within the map, an alternative route can be calculated. The direction to be travelled in is located in the variable dir, and the point to be driven to is given in post. The direction which ought to be travelled in according to the routing values of the server, is now determined. If the driver has in fact turned off the road at an incorrect place, this would be BACK. However, if an alternative route has already been calculated frequently, the alternative direction and the optimum direction may be the same. Thus, error-free navigation would be possible again because the alternative route corresponds to that calculated by the server. The variable drive_alternative is then reset to FALSE, and it is possible to wait until the vehicle reaches the point to be driven to post.

Detailed Description Text (166):
If a second unknown point is found, it is tested whether its intersection is directly connected to the intersection of the stored point. If this is the case, and if,

according to the traffic regulations (plus or minus sign on the map) it is also possible to pass successively through the two points found pos_found (first point found) and pos (last point found), it can be assumed that the vehicle is located at the measured position on the map. The alternative route can then be calculated for this position, and the system can wait for the direction of travel in the main loop.

Detailed Description Text (169):
If the vehicle has left the map excerpt which is present in the vehicle, there are two possible reactions: a new map corresponding to the area is requested or the vehicle is guided back into the known area using compass navigation. The method of operation of compass navigation is explained below.

Detailed Description Text (170):
Because compass navigation should be avoided as long as possible, when the driver leaves the area he is initially requested to turn back. The point to be driven to post is equivalent to the last point passed pos, as is shown in the program flow chart of the entire compass navigation process in FIG. 28. This last point passed becomes 0. The direction to be travelled in dir is BACK.

Detailed Description Text (171):
The program then changes into the status SearchWayHomeCoAbroad. Here, it is monitored whether the driver actually turns back. This is carried out according to the same principle as the finding of the direction of travel during error-free navigation. In contrast to the determination of the direction of travel, here it is monitored continuously whether the vehicle turns backs. The number of attempts is also counted, and when a maximum number of attempts has been determined the system is changed over to compass navigation.

Detailed Description Text (173):
If the program changes to compass navigation, the point which is to be made for is stored in post. In order to give a direction pointer for this point, the angle between this distance vector b=BZ and the driving direction of the vehicle a=AB is searched for--as is shown in FIG. 29.

Detailed Description Text (182):
The simulation of the navigation will demonstrate the method of operation of the "route" program or the communication between it and the TC, even without the data of a GPS receiver. As a result, the instructions are not assigned directly to the environment, but it is possible to perform stationary demonstrations for a relatively large number of observers.

Detailed Description Text (183):
In order to carry out this simulation, a simulation file must be created. To do this, the data of the GPS receiver are written to a file using the "infile" program. Then, while the "route" program is operating, the input from the serial interface can be diverted to this file.

Detailed Description Text (185):
Within the scope of the invention, a navigation system has been presented which is based exclusively on the position-finding with GPS and which does not require any further mechanisms. The navigation system can thus be installed quickly. The system can be utilized without difficulty for some vehicles by simply retrofitting.

Detailed Description Text (186):
A further advantage is also that the navigation can be carried out in an excerpt of a map with the smallest possible expenditure in terms of data. This is achieved with selective allocation of points for the respective ends of a street located on the map. The map matrix which is created can be expanded as desired and excerpts for the areas travelled through can easily be created. As a result of the low level of expenditure in terms of data, which is achieved by virtue of the allocation of points and the use of the map excerpts, it is possible to transmit the map excerpt to the vehicle by wire-free means. The data can thus be exchanged between a server and the navigation program.

Detailed Description Text (187):

The calculation of the "best possible" route from the map material is therefore based on the generation of routing values to the destination, which values permit a vehicle to be guided from any position on the map. They give a good compromise between the length of the route and the duration of the time of travel because, for example in the case of motorways on which is it possible to travel more quickly, fewer routing values are needed. In the case of supposedly relatively short routes through a town, a large number of branching-off streets can be expected, and does thus under certain circumstances not have the advantage over a motorway.

Detailed Description Text (188):
This calculation of a route can be exported to a provider of mobile services in order, firstly, to minimize the hardware requirements in the vehicle, and, secondly, to enable current traffic information and forecasts to be included in the calculation. In addition, roads may simply be closed or it may become more difficult to drive through them when the respective routing values increase in the case of traffic jams, roadworks, etc. Sections of road or even entire roads can be detected as a coherent unit in this respect.

Detailed Description Text (189):
However, the fact that there is only one map excerpt in order to minimize the data may have, under certain circumstances, disruptive effects for the user. If the vehicle has travelled beyond the boundary of the map, it is no longer possible to navigate. If a new map is requested for navigation, this costs the driver of the vehicle time and money. The compass navigation which is used does indeed constitute a compromise, but it is not convenient for the user because the arrow only serves as an orientation aid and cannot issue instructions to the driver.

Detailed Description Text (190):
However, directly connecting a navigation system to a mobile-radio service provider facilitates further development and implementation of related applications such as emergency call services and breakdown services, anti-theft systems, "floating car data" concepts, remote diagnostics and maintenance or information services unrelated to transport and traffic. If the data which are to be transmitted are compressed further, or even other transmission systems which are equipped with a higher transmission rate are used, it is possible to transmit a larger map excerpt. Said larger map excerpt can permit the driver to take incorrect actions repeatedly.

Detailed Description Paragraph Table (13):
File to load card (return = default): Read 47 points and 10 street names from file Please type in the first point you want to save (1 = load):1 File to load GPS-positions (return = default): Read 12 GPS-positions from file Please type in the first point you want to save (1 = load):5

Detailed Description Paragraph Table (14):
Press space bar to save GPS-position for point 5 (ESC or q quits) space: save point Fix quality: DGPS, satellites being tracked: 6 ->: RIGHT Time in seconds since last DGPS update: 2 <-: LEFT UP: STRAIGHT PDOP: 2.52 down: BACK 1.5-8.0 Position: 5131.2090 latitude n: next point 712.1249 longitude HDOP: 1.51 s: save 1.0-5.0 u: undo Speed: 37.3 km/h t: to do VDOP: 2.01 r: results Angle: 56.6 1.0-5.0 d: del street o: one-way street q: quit without saving straight. `Meesmann Street` (6) left: `Eickeler Way` (35) right: DEST (36) To `Meesmann Street` (5) Drive via `Meesmann Street` (4)... Ready to reach new point (speed is high enough)

Detailed Description Paragraph Table (16):
TABLE 8 The relevant variables of the "route" program Variable Name in program Explanation point [x] [u] map.fwdarw.point [x] [u] All the points surrounding point x point [x] [HIMSELF] The point itself in the vector for point x point [x] [RIGHT] Point to the right of point x point [x] [STRAIGHT] Point straight ahead of point x point [x] [LEFT] Point to the left of point x point [x] [BACK] Point "to the rear" of point x pos pos.fwdarw.position The last point passed through on map pre pos.fwdarw.pre_position The last but one point passed through on map post pos.fwdarw.post_position The next point on map to be driven to dir pos.fwdarw.orig_dir The next direction to be travelled in at post driven_dir pos.fwdarw.driven_dir The driven (determined) direction street [x] map.fwdarw.street [x] Reference of point to the street name streetname [x] map.fwdarw.street_name Street name of point x [street

[x]] post_dir map.fwdarw.point [post] [dir] The point which is reached at the next intersection after turning off streetname map.fwdarw.street_name[street Street name of point post_dir [post dir] [point [post] [dir]]] dest_street map.fwdarw.dest_street Number of destination street x = dest map.fwdarw.street [x] == Reference of street number is map.fwdarw.dest_street same number as destination street? (Destination reached?) status pos.fwdarw.route_status Status of navigation See Table 5.2

Detailed Description Paragraph Table (17):
TABLE 9 The statuses of the pos.fwdarw.route_status variable Status Explanation NoRoute No map or route present RouteIsCalculated Calculated route is received by server RouteIsCalculatedAndGaveInstr Instruction "route is calculated" has been given FindStartPosition Determination of starting position FindStartDirection Determination of driving direction at starting position PrepareToSearchNewPosition Preparations to search for new point SearchNewPosition Search new point and give instruction if appropriate SearchNewPositionAndGaveInstr Search point, instruction has been given FindDrivenDirection Determine driving direction DrivingAlternativeRoute Calculate alternative route DriveOverBorder Vehicle has left map, Instruction "Please turn round" PrepareToSearchWayHomeCo Preparations to search for new route Abroad outside the map SearchWayHomeCoAbroad Search for new route outside the map if vehicle has not turned round OrientateWithArrow Navigation using arrow ReachedDestination Destination has been reached

Detailed Description Paragraph Table (18):
<_HEAD LABEL = "Navigation" COMMAND = "DISPLAY" NO_OF_MAPS = "1" MODE = "HTML" SENDER = "NAV"> <_SABLE> In 800 meters. Please turn right into Eickeler Way. </_SABLE>

Detailed Description Paragraph Table (19):
<_HEAD LABEL = "Navigation" COMMAND = "DISPLAY" NO_OF_MAPS = "1" MODE = "HTML" SENDER = "NAV"> <HTML> <HEAD> <TITLE> Navigation Instruction </TITLE> </HEAD> <BODY> <CENTER> <H1> Eickeler Way </H1> </CENTER>

 <CENTER> <IMG SRC = file:/projects/stpad/visage/sw/graphics/icons/right.gif> </CENTER> <CENTER> <H1> in 800 m </H1> </CENTER>

 </BODY> </HTML>

Detailed Description Paragraph Table (20):
TABLE 10 Conversion of degree of latitude and longitude Point A: Bochum-Riemke Point B: Munster-South Data from GPS receiver 5131.0792 712.6727 5155.2385 733.5124 Data as sliding 51.5189 7.2187 51.9233 7.5642 decimal point value Data in radiant 0.89917385 0.12598984 0.90623240 0.13202078

CLAIMS:

1. Method for navigating an object starting from a starting point to a destination along traffic routes which are contained in an electronically stored traffic route map, and which traffic routes are provided with routing points, comprising steps of: assigning routing values to the routing points, which routing values, starting from the destination, are calculated in the manner of a propagating wave across the traffic routes, either only increase or only decrease as the distance from the destination in any traffic route grows larger; and navigating the object using the routing values which only decrease or only increase irrespective of the traffic route being followed.

12. Method according to claim 9, wherein the size of the map excerpt is determined by the positions of the starting point and destination.

13. Method according to claim 9, wherein, when the object leaves the area covered by the present map excerpt, a new map excerpt is called in which the routing values are assigned to the routing points with respect to the old destination and a new starting point.

14. Method according to claim 9, wherein, when the object leaves the area covered by the present map excerpt, a compass navigation back to the map excerpt takes place.

17. Method according to claim 1, wherein the object comprises a motor vehicle which receives its actual geographic position from a GPS receiver carried along on the motor vehicle.

19. Method for navigating an object starting from a starting point to a destination along traffic routes which are contained in an electronically stored traffic route map, and which traffic routes are provided with routing points comprising the steps of: assigning routing values to the routing points within a map excerpt of said stored traffic route map determined by the positions of the starting point and destination, which routing values, starting from the destination, are calculated in the manner of a propagating wave across the traffic routes, either only increase or only decrease as the distance from the destination in any traffic route grows larger; and navigating the object using the routing values which only decrease or only increase irrespective of the traffic route being followed.

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L14: Entry 30 of 56 File: USPT Oct 15, 2002

DOCUMENT-IDENTIFIER: US 6466862 B1
TITLE: System for providing traffic information

Brief Summary Text (3):
Commuters have a need for information relating to the congestion and traffic which they may encounter on a commute over a road, a highway, or a freeway. Unfortunately, the prior art methods of providing traffic information to commuters do not allow commuters to evaluate the extent to which there is congestion on a highway on which the commuter may wish to travel.

Brief Summary Text (4):
One known method of providing traffic information consists of radio reports. A radio station may broadcast traffic reports, such as from a helicopter that monitors traffic conditions over portions of a freeway. Unfortunately, these reports are usually intermittent in nature. Accordingly, to hear the report, the commuter must be listening to the radio station at the time the report is being broadcast on the radio. Further, the extent of the information provided is severely limited to broad generalizations. For example, the information provided during the broadcast may be limited to the area being currently viewed by the reporter, or the information may be based on a previous view at a prior time of another portion of the freeway. Some broadcasts may include multiple observers of different portions of the freeway, yet these systems also provide incomplete information relating to overall traffic patterns. In addition, the information provided is vague, subjective, and usually limited to broad generalities relating to traffic flow.

Brief Summary Text (5):
Another known traffic information system is provided by television broadcasts. In these systems, television stations may mount video cameras pointed at certain portions of a freeway, or may broadcast video images from a helicopter. The television station may periodically broadcast traffic reports and include in the traffic report a view of different portions of the freeway from the video cameras. Again, this system provides little useful information to a commuter. The commuter must be watching the broadcast at the time the information is being transmitted. However, by the time the commuter actually gets into his vehicle and enters a potentially congested area, the traffic may have changed. Further, the information provided is limited to those areas where the traffic is being monitored and may consist of stale information. Often the video image is limited to a small portion of the road, and shows traffic flowing in a single direction.

Brief Summary Text (7):
Fan et al., U.S. Pat. No. 5,959,577, disclose a system for processing position and travel related information through a data processing station on a data network. In particular, Fan et al. teach the use of a GPS receiver to obtain a measured position fix of a mobile unit. The measured position fix is reported to the data processing station which associates the reported position with a map of the area. Typically, the measured position of the mobile unit is marked and identified by a marker on the map. The area map is then stored in the data processing station and made available for access by authorized monitor units or mobile units. An authorized monitor unit may request a specific area map. This permits shipping companies to monitor the location of their fleet and permits the mobile units to identify their current location in relation to a map, which is particularly suited for the application of navigation to a particular destination. In addition, Fan et al. teach that the measured position data

transmitted from the mobile units may be used to calculate the speeds at which the vehicles travel. The collective speed data from the mobile units is then available for use by the monitor units, such as those at the shipping company, to route the vehicles away from traffic congestions and diversions. In this manner, the dispatcher at the shipping company, to which Fan et al. teaches the data is available to, may use the collective speed data to decide which vehicles to contact in order to reroute them.

Brief Summary Text (9):
Zijderhand, U.S. Pat. No. 5,402,117, discloses a method of collecting traffic information to determine an origin-destination matrice without infringing upon the privacy of the users.

Brief Summary Text (12):
Smith, Jr. et al., U.S. Pat. No. 5,774,827, disclose a system to alleviate the need for sophisticated route guidance systems, where the commuter has a positioning system as well as a map database in a car. A central facility receives and stores current traffic information for preselected commuter routes from various current traffic information sources, such as local police authorities, toll-way authorities, spotters, or sensors deployed on the road ways to detect traffic flow. To achieve the elimination of sophisticated route guidance systems a portable device receives a travel time only for preselected commuter routes from the central facility. In this manner, Smith, Jr. et al. teach that each user receives only the traffic information that is relevant to the user's preselected commuter routes. If desired, the preselected commuter routes may be presented as a set of route segments, where each of the segments is coded to indicate commute time. In response, the user may choose an alternative route known by him that is different from any preselected commuter routes. Smith, Jr. et al. further suggest that a GPS enabled portable unit for transmitting a present position of the portable device to the central facility such that the central facility uses each present position to calculate at least a portion of the current travel information. By matching multiple positions of the portable device with known positions on the preselected route and measuring the time between two consecutive matched positions the central facility can obtain up-to-the minute traffic information to be used in broadcasting future travel times to other users of preselected commuter routes. Unfortunately, the system taught by Smith, Jr. et al. requires the user to define a set of preselected commuter routes for each route to be traveled, which may be difficult if the user is unfamiliar with the area. In addition, Smith, Jr. et al. teach that the user should select alternative routes that are known to the user, presumably if the commute time of the preselected commuter routes are too long, which is difficult if the user is not already familiar with the area.

Brief Summary Text (14):
Akutsu et al., U.S. Pat. No. 5,987,374, disclose a vehicle traveling guidance system that includes data providing devices laid on a road and a vehicle. The vehicle includes a data transmitter for sending a data providing device traveling data of the vehicle when the vehicle passes over the vicinity of the data providing device and a data receiver for receiving data sent from the data providing device. The traveling data may include vehicle pass time or vehicle pass time and speed. The data providing devices laid on the road include a receiver for receiving the traveling data from the vehicle and a transmitter for sending other passing vehicles the traveling data. A control center communicating through the data providing devices laid on the road can use the received traffic data from the vehicles to predict the occurrence of traffic congestion based on the pass time and speed of a vehicle. It is assumed that at a certain point, vehicles were traveling smoothly at a certain time and the speed of each vehicle has decreased drastically at the next time. In this case it is expected that traffic congestion will occur in the vicinity of that point. Therefore, smooth travel can be achieved by, for example, communicating to each vehicle data etc. indicating bypasses in order not to worsen traffic congestion. Therefore, a vehicle operator can gain knowledge of the traveling state of a vehicle which has already passed over that point and adjust travel considering traffic flow.

Brief Summary Text (19):
In a third separate aspect of the invention, a system provides traffic information to a plurality of users connected to a network. The system comprises a plurality of mobile user stations, each mobile user station being associated with the display, a global positioning system receiver and a communicating device to allow each of the

mobile user stations to send and receive signals. A computer system is interconnected with another communicating device in the network. The computer system is capable of sending and receiving signals to the mobile user stations using the other communicating device in the network. The computer system maintains a map database and a traffic information database. The traffic information database contains information representative of traffic data at a plurality of locations. At least one of the mobile user stations provides a request to the computer system for information together with the respective geographic location of the mobile user station. In response to the request, the computer system provides to the mobile user station information representative of selected portions of the map database and selected portions of the traffic information database based on the respective geographic location of the requesting mobile user station. The mobile user station then displays graphically on the display information representative of selected portions of the map database and selected portions of the traffic information database.

Brief Summary Text (20):
The traffic information database may be derived from information obtained from stationary traffic monitors, mobile user stations, or a combination thereof. The mobile user station allows traffic information to be displayed in a variety of manners. The display can also show graphically the location of the car on the display. The user may select among different modes for displaying traffic information on the display.

Drawing Description Text (4):
FIG. 3 shows an exemplary display for a user station.

Drawing Description Text (9):
FIG. 8 shows another exemplary display for a user station.

Drawing Description Text (17):
FIG. 16 is a schematic diagram of a mobile user station having alternative mechanisms for inputting commands to the user station.

Detailed Description Text (2):
Referring now to the figures, wherein like numerals refer to like elements, FIG. 1 shows a schematic diagram of the system 10 for providing traffic information to a plurality of user stations 52 connected to a network 50. A plurality of traffic monitors 20 are arranged at spaced apart locations along a road 12. The traffic monitors 20 measure traffic information by detecting the speed (velocity) or frequency of vehicles traveling along the road (freeway or highway) 12. For example, in one embodiment, the traffic monitors 20 may detect. the speed of individual vehicles 14 traveling along the road 12. Alternatively, the traffic monitors 20 may measure the frequency with which the individual vehicles 14 pass specified points along the road 12.

Detailed Description Text (3):
FIG. 2 shows a front elevational view of an exemplary embodiment of a traffic monitor 20. The traffic monitor 20 has a detector 22 for measuring or otherwise sensing traffic. FIG. 2 shows two different embodiments 22A and 22B of a detector 22. The detector 22 may be any type of measuring device which is capable of measuring or otherwise sensing traffic and generating a signal representative of or capable of being used to determine the traffic conditions. For example, the detector 22 could measure the average speed of the vehicles (cars or trucks) 14 at locations along the road 12, or it could measure the individual speed (velocities) of each vehicle 14. The detector 22 may detect vehicle frequency, that is, the frequency at which vehicles pass a certain point, or may measure traffic flow, consisting of the number of vehicles passing a certain point for a unit of time (e.g., vehicles per second). The detector 22 may use any suitable technique to measure traffic conditions (data). For example, in one embodiment, the detector 22A could employ radio waves, light waves (optical or infrared), microwaves, sound waves, analog signals, digital signals, doppler shifts, or any other type of system to measure traffic conditions (data). In one embodiment, the detector 22A uses a transmitted beam to measure the velocity of the vehicles 14 passing along the road 12, such as with a commercial radar gun or speed detector commonly used by police. Alternatively, the detector 22A may detect when cars having magnetic tags or markers pass. The detector 22A may either detect

signals reflected from the vehicle or signals transmitted by the vehicles.

Detailed Description Text (15):
The receiver 30 receives the information from the traffic monitors 20 and/or video cameras 29 and passes that information to a computer system 40. The computer system 40 preferably includes a processor (such as a general purpose processor, ASIC, DSP, etc.), a clock, a power supply, and a memory. The computer system 40 preferably has a port 42, or any type of interconnection, to interconnect the computer system 40 with the network 50. Preferably, the computer system 40 includes information representative of the road 12 along which the traffic monitors 20 are located, such as a map database. The computer system 40 receives the traffic information transmitted by the respective traffic monitors 20. The information transmitted by the traffic monitors 20 includes the location or identification of each particular traffic monitor 20 together with the data representative of the traffic data provided by the detector 22 and/or video camera 29 at each traffic monitor 20. The computer system 40 may manipulate the traffic information in some manner, as necessary, so as to provide average speeds or other statistical data. In the event of video, the computer system 40 may process the images to determine the speed of vehicles. Also, the video may be provided. Alternatively, the user stations may process the traffic information.

Detailed Description Text (17):
Traffic information may be provided to users in any suitable manner, such as the examples that follow. A user station 52 is connected to the network 50. Preferably, the user station 52 includes a graphic display unit 54 (see FIG. 3). For example, the user station 52 may be a standard personal computer with a display monitor 54. The network 50 is preferably the Internet. However, the network 50 could also be a local area network or any other type of closed or open network, or could also be the telephone network. The user station 52 sends a signal over the network 50 to the computer system 40 requesting traffic information. In response to receiving a request from the user station 52, the computer system 40 transmits traffic information representative of the traffic information collected by the various traffic monitors 20 to the requesting user station 52. The computer system 40 may transmit average speeds detected by each of the traffic monitors 20 at each of their respective locations. The traffic information may be presented to the user as a web page. The computer system may send traffic information corresponding to only some of the traffic monitors. The user may select which portions of the road 12 are of interest, and the computer system 40 may transmit traffic information corresponding to that portion of the road 12.

Detailed Description Text (18):
FIG. 3 shows an exemplary display 54 displaying the traffic information provided by the computer system 40. The computer system 40 provides data from its memory which is representative of the road 12, such as data from a map database, which is displayed as a road 112 on the display 54. The computer system 40 also provides traffic information collected by each, or a selected set, of the respective traffic monitors 20 which is displayed in portions 114a-114d and/or the traffic information derived from individual mobile user stations having a global positioning system locator as described in detail below. In the exemplary display shown in FIG. 3, the portions 114a-114d display different colors or patterns representative of average vehicle speeds (for example, in miles per hour) along different portions of the road 112. Of course, the display may display other types of information, such as traffic flow (vehicles per second) or vehicle frequency. The display 54 may include information in either graphical or text format to indicate the portion of the road displayed, such as location of milepost markers or place names 116.

Detailed Description Text (20):
Thus, the system may operate as follows. The traffic monitors 20 detect or otherwise sense traffic to provide traffic information. The traffic monitors 20 may detect or otherwise calculate vehicle speed, average vehicle speed, traffic flow, vehicle frequency, or other data representative of the traffic. The traffic monitors 20 may sample either continuously, or may sample at intervals to conserve power. The transmitter 26 transmits the signals provided by the traffic monitors 20 to the receiver 30 either continuously or at intervals. Such signals may be either transmitted directly to the receiver 30, or may be transmitted through other traffic monitors 20. The receiver 30 receives the signals received by the various traffic monitors 20 and passes these signals to the computer system 40. The computer system 40

receives the data from the traffic monitors 20. The computer system may calculate or process the traffic information for the users, as necessary. It is not necessary for the traffic monitors 20 to calculate traffic data, if desired. In response to a request from a user station 52, the computer system 40 provides the traffic information over the network 50 to the user station 52.

Detailed Description Text (21):
The system 10 has many advantages. ~~It allows a user to receive contemporaneous~~ traffic information from a plurality of ~~locations~~. It allows the user to obtain immediate information ~~rather than~~ waiting for the broadcast of information at specified times. Further, the amount of information provided by the system is far superior to that provided by any other traffic reporting system. A user can obtain immediate and contemporaneous traffic conditions, such as average vehicular speed, traffic flow, or vehicle frequency, for a plurality of locations along a road. Where traffic monitors are provided along several different roads, a commuter may then select among the various alternative routes, depending on the traffic conditions for each road. The system also does not rely on the manual input of information, and thus provides information more accurately and more quickly. It also eliminates subjective descriptions of traffic information by providing measured data representative of traffic conditions.

Detailed Description Text (23):
The system 10 preferably further includes the ability to send messages about road conditions. FIG. 3 shows such an exemplary message 130 in text format. The computer system 40 is capable of storing data messages and transmitting the data messages with the traffic information. The data messages would indicate items of particular interest to the commuter. For example, the text message 130 could indicate that there was an accident at a particular location or milepost, that construction was occurring at another location or milepost, or that highway conditions were particularly severe and that alternative routes should be selected. The system 10 could provide multiple messages through which the user could scroll so as to receive different messages in addition to the traffic information received from the various traffic monitors 20. In another embodiment, the user station 52 includes a voice synthesizer capable of reading the messages to the user.

Detailed Description Text (24):
In yet another embodiment, the system 10 may also provide additional graphical information relating to traffic conditions. For example, the computer system 40 could transmit the location of an accident or construction site along the road 12. The information would be displayed on display 54 as an icon or other symbol at the location indicating the presence of an accident or highway construction. Such an icon is shown at 140 in FIG. 3. Alternatively, the computer system could also display an icon representative of a restaurant, gas station, hospital, rest area, or roadside attraction. In such a system, the computer system would contain or be linked to a database containing such information. The information could be displayed automatically, or in response to a request for such information from a user.

Detailed Description Text (25):
In another exemplary embodiment, the computer system 40 automatically generates traffic reports to be sent to the user station 52 at predetermined times. For example, a user may indicate that it wishes to receive a traffic report every morning at 7:30 a.m. The computer system 40 automatically sends to the user station 52 at the predetermined time (7:30 a.m., for example) the traffic information collected from the traffic monitoring units 20. The information could be sent to be displayed, such as in FIG. 3, or could be sent alternatively in a text or graphical format via e-mail. The traffic report may also be provided in a format specific to the user's geographic region and/or user's driving habits, such as anticipated (potential) route to be traveled. The computer system 40 may also automatically send the traffic information to a display in the user's vehicle in response to some event, such as turning on the vehicle, time, key press, etc.

Detailed Description Text (26):
In another embodiment, the computer system 40 allows a user to calculate the amount of time necessary to travel from one location to another location along the road 12. The user sends a request to the computer system 40 indicating the two locations along the

road along which travel is desired. The user may, for example, indicate on the display by highlighting the two locations on the road 112 using a computer mouse. Alternatively, the two locations may include the user's current location, as determined by a vehicle based GPS system, so that only the destination needs to be entered. The computer system 40 then calculates the anticipated amount of time it will take to travel from one point to the other point based upon the traffic data collected by the various traffic monitors 20 between the two locations. In addition, the system may calculate alternative routes in order to determine the fastest route in view of the traffic information. The computer system 40 then sends a signal back to the user station 52 to indicate the amount of time that the travel from the first to the second location will take. The route determined as the best may be overlaid on a map to assist the user in travel.

Detailed Description Text (29):
FIG. 4 shows an alternative embodiment of a user station 52. User station 52 is a mobile unit in a car 60. User station 52 has transmitting and/or receiving units 64 for communicating with the network 50. Such transmitting and receiving units 64 may be any devices capable of transmitting digital or analog data, such as, for example, a digital or analog cellular phone.

Detailed Description Text (30):
The user station 52 may also be contained within a car 60 that further includes an associated global positioning system (GPS) receiver 62. The GPS receiver 62 receives signals from GPS satellites 70 which enable the GPS receiver to determine its location. When a commuter requests traffic information using the mobile user station 52, the request for traffic information may include the location of the user as determined by the GPS receiver 62. When the computer system 40 receives this request, it provides traffic information back to the mobile user station 52 based on the location of the car 60 as provided by the GPS receiver 62. Alternatively, the computer system 40 may provide traffic information to the user station 52 which in combination with the position determined by the GPS receiver 62 displays suitable data to the user on a display or audibly. The user station may also be a cellular phone with an integrated or associated GPS.

Detailed Description Text (31):
FIG. 6 shows a representative display of the traffic information provided by the computer system 40. The information provided is essentially the same as that shown in FIG. 3, except that the display 54 contains at 161 the position of the car 60. The mobile user station 52 provides a significant advantage in that it allows the commuter to immediately determine traffic information in the commuter's immediate vicinity based on the commuter's present location. The commuter does not have to wait for a periodic traffic report. Further, traffic conditions are provided at a plurality of locations, and the information is contemporaneous. Based on the receipt of such information, the commuter may decide to use an alternate route rather than continue on the current freeway.

Detailed Description Text (32):
Thus, in the embodiment shown in FIG. 4, the system provides the relevant traffic information to the commuter or user on a timely basis. The display may be tailored to provide the information for the current location of the commuter, together with the upcoming traffic that lies ahead.

Detailed Description Text (33):
In a preferred embodiment, the system obtains traffic information from users that have a GPS receiver 62. In this system, whenever a user station 52 requests traffic information from the computer system 40, the computer system 40 associates a velocity (speed) of that particular user with its current location. The velocity may be determined through a variety of methods. In one system, when the user requests traffic information, the user station 52 supplies not only its location but also its current velocity. The user station 52 may obtain its current velocity in any fashion. For example, the user station 52 may track its location over time using the GPS receiver 62, and also keep track of the time associated with each location by using an internal clock. The velocity could then be calculated by simply dividing the difference between respective locations by respective times. Alternatively, the user station 52 may be connected to the vehicle's speedometer or odometer, and measure velocity using

information provided by the vehicle 60 itself. Alternatively, the computer system 40 itself could calculate the velocity of each user. In such a system, each user station 52 would provide the computer system 40 with a unique identification code together with its location. The computer system 40 then associates a time using an internal clock with each location reported by each user. Preferably, the GPS location is sent together with the current time at the user station so that delays incurred in transmission do not change the result. The velocity of each user could then be calculated by calculating the difference in location for a particular user (identified by its unique identification code) by the respective times associated with each of these locations.

Detailed Description Text (34):
Thus, the computer system 40 develops a database consisting of the location of a plurality of users together with the respective velocities of each of the users. The computer system 40 thus has traffic information consisting at least of the velocity of the traffic for a plurality of locations corresponding to the locations for each of the reporting users. It is preferred in such a system that each user station 52 would contribute to the database, but the computer system could use data from fewer than all of the user stations 52 either requesting information or operating. The system may thus use the information received from the user stations 52 either to calibrate the traffic information provided by monitors 20, or to supplement the traffic information provided by the traffic monitors 20. Alternatively, where the number of users is sufficiently large, the traffic monitors 20 may no longer be necessary, because the users themselves through mobile user stations 52 and GPS receivers 62 provide enough traffic information to generate useful displays of traffic information. Thus, the system may provide traffic information without the use of monitors 20 at all, relying solely on information derived from the mobile user stations 52. With a large number of users at a plurality of different locations, the computer system 40 would develop a database having a large number of velocities associated with a large number of geographic locations. Ideally, if every commuter on a road had a user station 52 with a GPS receiver 62, the computer system 40 would provide not only velocity data but also traffic density or traffic frequency data. Even without every vehicle having a user station 52 providing data to the computer system 40, traffic density or traffic frequency could be calculated using statistical techniques that correlate the reporting user stations 52 with known traffic patterns.

Detailed Description Text (35):
Thus, the combination of the mobile user station 52, GPS receiver and transmitting and receiving units 64 provides an especially advantageous method for collecting traffic information. Surprisingly, this system is capable of providing traffic information that is superior to that collected by stationary sensors. This is because traffic information may be potentially collected at more locations based on the number of mobile user stations 52, and because individual vehicle speed can be monitored rather than average vehicle speed. In addition, the system has a significant cost advantage in that it is not necessary to install traffic monitors 20, or at least the number of traffic monitors 20 that are necessary can be substantially reduced. The system also provides automatic traffic reporting, and thus does not rely on the manual input of data. Furthermore, the system is low maintenance, since there are no traffic monitors 20 to maintain. The system is also particularly robust, in that if a particular mobile user station 52 malfunctions, traffic information can still be collected for all locations based on data reported by other mobile users. In contrast, if a stationary sensor 20 fails, no data can be collected from that location. Thus, the collection of traffic data from a plurality of mobile user stations 52 to create a traffic information database provides surprising advantages and a superior system for providing traffic information.

Detailed Description Text (36):
In the system described above using mobile user stations 52 in vehicles, the user station may initiate contact with the computer system 40 by initiating a telephone call to the computer system 40. Alternatively, the computer system 40 could initiate a call to the user station 52, such as over the Internet using a web browser. The user station 52 would respond with an appropriate signal if information was requested. The user station 52 could also, even if no information was desired, provide its current location (preferably with current time), and optionally its velocity as well, to allow the computer system 40 to gather additional traffic information. This would be useful

in the case of vehicle based Internet browsing for other purposes so that the traffic information would be updated for that user and others. In yet another alternative, the user station 52 would initiate the request to the computer system 40, indicating that traffic information was desired. The computer system 40 would then respond at a series of timed intervals for a set length of time, for example, providing updates every two minutes for thirty minutes.

Detailed Description Text (37):
In yet another alternative embodiment of the system 10, the mobile user station 52 is a cellular telephone. The computer system 40 includes a voice synthesizer. A user may telephone the computer system 40 over a cellular telephone network. In response to a request for highway conditions, the computer system 40 generates a traffic report and transmits the information using the voice synthesizer so that the traffic information may be heard and understood over the commuter's cellular telephone. The location of the user may be determined by an associated GPS receiver, or alternatively by triangulating the location of the user by measuring the distance between the user and several different transmission receiving towers in different cells.

Detailed Description Text (38):
In yet another embodiment of the present invention the computer system 40 or user station 52 may calculate the best route, such as the fastest, between a starting point and a destination based on the current traffic conditions. This functionality may further be provided in the mobile user station 52 in the car 60 so that the driver may calculate the best route to accommodate for changing traffic conditions. This also assists the driver in unfamiliar cities where he may be unfamiliar with anticipated traffic patterns. The functionality of providing current traffic conditions and/or best route calculations may be overlaid on maps available for GPS systems, household computers, and mobile user stations.

Detailed Description Text (39):
In addition, an early warning system may be incorporated into the computer system, user station, or mobile user station to provide warning of impending traffic jams, such as the result of a traffic accident. For example, if the average vehicle speed on a portion of a road ahead of a driver is less than a preselected velocity, such as 25 mph, the computer system 40 may send a warning signal to the mobile user station 52. Alternatively, a velocity less than a preselected percentage or other measure of the anticipated velocity for the particular road may be used as the warning basis. It is also envisioned within the scope of the invention that data communications may be accomplished using radio broadcasts, preferably encoded in some manner.

Detailed Description Text (40):
Preferably, the computer system 40 and/or the mobile user station 52 in a vehicle 60 has stored in its associated memory a map database representative of the road or highway network that contains longitude and latitude information associated with various geographic locations on the map. This allows easy integration of traffic data that has associated longitude and latitude information. For example, along a particular section of a highway, the map database contains the latitude and longitude of selected locations of the highway. The latitude and longitude of the various traffic sensors 20 may be predetermined. When data representative of the traffic at a particular sensor 20 is received, the computer system 40 can easily display the traffic information for that particular location on the map by associating the geographic location of the sensor 20 with the longitude and latitude information contained in the map database. Similarly, where traffic information is derived from individual mobile user stations 52 in vehicles 60 which report latitude and longitude derived from the mobile GPS receivers 62, the computer system 40 can easily associate the traffic information received from the mobile user station 52 with the map database based on the user's reported latitude and longitude. Thus, by utilizing a map database that contains latitude and longitude information for various locations, the system can easily overlay traffic information on top of the displayed map data by associating the geographic data (latitude and longitude) corresponding to the traffic information with the geographic data corresponding to the map.

Detailed Description Text (41):
FIGS. 11 to 12 illustrate such a system. FIG. 11 shows schematically a section of a road having various locations 201-218. Along the road are positioned various sensors

20a-20d whose geographic locations have been determined. Traveling along the road are a variety of users 401-404 having respective user stations and GPS receivers. FIG. 12 illustrates one embodiment of a map and traffic information database that may be developed to provide traffic information over the network to individual users. Each of the various locations (or road segments) 201-218 has an associated longitude and latitude. In addition, the database may optionally contain the associated road, as well as optionally the direction that traffic moves at that location (for example, using a 360 degree compass, 0 degrees would represent straight north while 90 degrees would represent straight east). The database also includes traffic information, such as the average vehicle velocity calculated for that location. Thus, for example, referring to FIG. 11, the traffic monitor 20a may be used to provide the vehicle velocity for location 202. User 401 may be used to provide the vehicle velocity at location 210.

Detailed Description Text (42):
Of course, while a database has been illustrated that combines both map and traffic information, the system could use two or more databases containing portions of the information, such as a separate map database and a separate traffic information database. An example of a map database useful with such a system is Etak Map.RTM. from SONY.RTM.. The map database could reside on either or both the computer system 40 or the mobile user station 52.

Detailed Description Text (43):
When a user requests traffic information from the computer system 40, the computer system 40 transmits the requested data based on either the geographic location of the user, or for the geographic location requested by the user. The computer system 40 either sends the raw traffic data requested by the user, or sends a signal representative of the map and/or traffic database which may be used by the user station 52 to represent the map and traffic information on the display 54.

Detailed Description Text (44):
The advantage of using a map database that contains longitude and latitude information associated with various locations on a map is that the system allows easy and automatic integration of traffic information, either to a database or for display. Thus, traffic information may be collected from an individual user who provides the longitude and latitude for that user based on information derived from the user's GPS receiver 62. The computer system then matches the location of the user to the map database based on the received longitude and latitude information. The computer system 40 can then overlay the traffic information data received from the user onto the map database based upon the provided longitude and latitude information. Thus, the system allows traffic information to be updated for a map database, even though the routes of the individual users are not predetermined. In other words, it is not necessary to know the particular route of an individual user in order to collect useful traffic information and to update a traffic information database.

Detailed Description Text (48):
The present invention provides several alternative methods for displaying traffic information to a commuter using a mobile user station 52. These various alternatives allow the user to customize the display 54 to provide the desired information, and to minimize the amount of operation needed while driving. In one display embodiment, the display 54 centers the location of the user on the displayed map, and is referred to herein as the "Centered Display." In the Centered Display, the mobile user station 52 determines the longitude and latitude of the commuter based on information obtained from the GPS receiver 62. The mobile user station 52 then displays the position of the commuter at the center of the display 54 as shown in FIG. 13. The traffic information and roadway data is then displayed around the commuter by comparing the longitude and latitude of the user with the longitude and latitude associated with the various map locations contained in the map database. The individual user may preselect the scale of the map which will be displayed based on the user's preference. For example, the user may wish to show an area of one mile radius centered around the user, or two mile radius, or so forth. As the user drives along a road and the user's geographic location changes, the user station 52 and/or computer system 40 adjusts the display 54 to reposition the map and traffic information on the display 54. Thus, the map and traffic information scroll along the display 54 as the user moves along a road. For example, if the display 54 shows map and traffic information at a scale of one inch

per mile and the direction north is shown at the top of the display, the map and traffic information would scroll down one inch as the user drives one mile north. The display 54 would continuously show the location of the user at the center of the display 54 even though the geographic location of the user changes.

Detailed Description Text (49):
A particular advantage of the Centered Display as discussed above is that the location of the user can immediately be ascertained from a quick glance at the display 54, because the location of the user is always at the center of the display 54. The user is not required to adjust the display 54 by input ting information to the user station 52 in order to constantly view the surrounding traffic information, even as the location of the user changes. Thus a commuter, by selecting the Centered Display, may view constantly updated traffic information for his location without requiring any input from the commuter.

Detailed Description Text (50):
Alternatively, the display may be preselected to show the location of the user at a different location on the display 54, but that continues to show the geographic location of the user at a single location on the display 54, even as the geographic location of the user changes. This is referred to as an "Offset Display." This is a variation of the "Centered Display," but allows the user to adjust the display 54 to show more information of interest to the user. For example, if the user is traveling north, and north is shown at the top of the display 54, the user may choose to display his location near the bottom of the display (offset from the center) so as to display a greater amount of traffic information in the northern direction. Such a display is shown in FIG. 14. Like the "Centered Display," as the geographic location of the user changes, the map and traffic information is automatically scrolled to show the surrounding road and traffic, while maintaining the location of the user on the display 54. The "Offset Display" is particularly suited for driving along a relatively straight road, so that the user has relatively more upcoming traffic information displayed.

Detailed Description Text (51):
Yet another alternative display allows the user to display upcoming traffic information for the road on which the user is traveling, referred to herein as the "Look Ahead Display." In the Look Ahead Display, the display 54 displays the location of the user near an edge of the display 54 so as to maximize the amount of upcoming road and traffic information which is displayed. In the Look Ahead Display, the computer system 40 and/or the user station 52 determines the direction of the user based on data received from the GPS receiver 62 and compares that direction to the road the user is traveling on. The map and traffic information is then selected so as to maximize the amount of road shown ahead of the driver. The user may select to either display the map and traffic information so that the cardinal ordinates North, South, East and West remain fixed (for example North is always at the top of the display) or the road is generally centered (for example vertically on the display) without regard to the cardinal ordinates. For example, when the display maintains North at the top of the display, and the user is traveling south, the display 54 would display the location of the user near the top of the display 54, so as to increase the amount of the road ahead of the user that is displayed. If the road then curved, so that the user was heading in an easterly direction, the display 54 would show the location of the user near the left hand side of the screen so as to display the road ahead to the east (east appearing on the right hand side of the screen). This is illustrated in FIG. 15. By constantly comparing the direction of movement of the user, as determined from the data received from the GPS receiver 62, with the road information contained in the map database, the system maximizes the amount of map and traffic information displayed based on the location and direction of travel of the user.

Detailed Description Text (52):
Yet another type of display is the "Stationary Display." In this type of display, the underlying map data remains "motionless" while the displayed location of the user changes according to the movement of the user. For example, initially, the user's geographic location on the map may be shown at the center of the screen. As the user moves along a road, the user's location would change on the display 54, while the position of the road relative to the screen would remain constant. (An example of such

a display is shown in FIG. 6). If the user moved to a location not displayed, a new map would be displayed, showing the location of the user on the new map screen. The Stationary Display is useful where the map database is divided into discrete units that roughly correspond to "pages." The Stationary Display can show the map data corresponding to a particular page on the display 54. New pages can be shown as the user's location changes. The Stationary Display may be preferred where the user is familiar with the surrounding area. The Stationary Display may also be less disconcerting to the user, because only a small portion of the screen is changing (the displayed location of the user) as the user's geographic location changes. The Stationary Display may also achieve some efficiencies for the system, because the computer system 40 would only be required to send enough data to fill display 54 to show the map for the area surrounding the location of the user and then update as necessary for new traffic information. Thus, the map database could be divided into discrete portions, each portion containing enough information to fill a display. In response to a request from a mobile user station 52 providing location information derived from the GPS receiver 62, the computer system 40 identifies the corresponding portion of the map database to the user station 52. The user station 52 may manage the task of integrating the map database with the user's location to display the geographic position of the user.

Detailed Description Text (54):
Yet another mode for displaying map and traffic information is to display a particular area of interest (referred to as the "Area Display"). The Area Display displays a particular geographic area of interest to the commuter. The location of the commuter may or may not be displayed, depending on whether the commuter is located within the area. To receive an Area Display, the mobile user station 52 transmits the location of the area of interest, and in response, the computer system 40 provides pertinent map and/or traffic information. The Area Display may be especially advantageous where the commuter wishes to view a particular area of interest that may be some distance away from the commuter.

Detailed Description Text (56):
Various alternatives may be used to command the user station 52 and/or computer system 40 to display map and traffic information. In one embodiment, where the network is the Internet, the system may provide a settings preference web page to the user to allow the user to select the user's individual display settings. Thus, the user may select the scale of the display (i.e. one inch of display equals one geographic mile); the size of the display (to accommodate different screen sizes); the frequency at which the map and traffic information is updated; the particular default display type (such as the "Centered Display," "Look Ahead Display," "Stationary Display," "Area Display," or other type); and whether information banners are to be displayed. The ability to choose the frequency with which traffic information may be updated may be useful to allow the user to control the cost of providing the information to the user. For example, where the cost of being connected to the network is high, the user may wish to receive only short periodic updates (such as an update every five minutes) to reduce the expense of receiving data.

Detailed Description Text (58):
In addition to default settings, or settings that are preset by the user, the user station 52 may be capable of receiving input from the user to actively change how information is displayed in response to user commands. In one embodiment, the user station 52 includes a microphone 53 and voice recognition software to allow the user station 52 to respond to the voice commands of the user. (See FIG. 16). Thus, the user may by using verbal commands select a particular mode of display, request an update of the traffic information, or change the scale of the map. Alternatively, the user station 52 may have a keyboard to accept input commands via the keyboard. Alternatively, the user station may have only a control panel 55 having several key pads 57 which correspond to particular types of preset commands.

Detailed Description Text (59):
For example, one key pad may allow a user to request traffic information. Another key pad may allow a user to zoom in on the map (i.e. change scale to show more detail), while another key pad would cause the display to zoom out (i.e. change scale to show more area). Another key pad may select for the Stationary Display, while yet another may select for the Look Ahead Display. The user station 52 may allow the user to

preset the key pads 57, such as via a web page preferences page, so that the key pads correspond to the user's particular preferences. The use of key pads to select the mode in which information is displayed has several advantages. The key pads eliminate fumbling by the commuter, and thus are safer to use than a keyboard. They keypads also allow the user to quickly move between different types of modes of presentation, so that the commuter may maximize the amount of information received.

Detailed Description Text (60):
When using data from individual mobile user stations 52 to determine traffic information, it may be desirable to screen the data to determine whether it will be included in the traffic information database. One type of screening may involve comparing the geographic location of the user with particular features stored in the map database. For example, where the user is located at a stop sign, it may not be desirable to include the user's reported velocity in the database. The computer system 40 may be programmed so that data received from users at stop signs will not be added to the traffic database. Accordingly, when the user reports its geographic location, the computer system 40 compares the geographic location of the user with the map database. When the computer system 40 determines that the user is located at a stop sign (or other location, as desired), the data is rejected. Thus, the vehicle speed data transmitted by the user is screened based on the particular location of the user.

Detailed Description Text (62):
Another type of screening that may be desired is to compare the direction of travel of each user with the direction of travel on various roads before adding the user's vehicle speed to the traffic information database. This may be particularly important where the resolution of the GPS receiver 62 is such that the location of the user may be confused with one or more roads. For example, a user may be traveling along a divided road with lanes of traffic traveling in opposite directions, but the resolution of the GPS receiver 62 does not allow the computer system 40 to determine with confidence in which lane the user's vehicle is traveling. In order to determine what portion of the traffic information database to update, the computer system 40 and/or user station 52 creates a directional vector associated with the user which represents the user's direction of travel. The directional vector is determined based on the movement over time by the user. For example, the directional vector may be represented by a number ranging from 0-359; with 0.degree. representing travel straight north, 90.degree. straight east, etc. When information is received by the computer system 40, it compares the directions of travel of the various roads near the geographic location of the user with the user's directional vector. For example, the geographic information reported by the GPS receiver 62 indicates that the user is located near a particular road that has north/south lanes with traffic traveling in each direction. The user's directional vector indicates that the user is traveling south. The computer system 40 therefore updates the traffic information database to add the data received from the user to the traffic information database for the lanes of traffic moving in the user's direction of travel. Other instances in which the directional vector would be useful would be where a user is crossing a particular road, such as when traveling along an overpass or an underpass, and the resolution of the GPS receiver is such that the computer system 40 is unable to determine with confidence on which road the user is traveling. The use of the directional vector thus prevents the computer system 40 from incorrectly updating the traffic information database. In addition, the altitude component of the GPS data may be used to discriminate between users on overpasses or roads that are vertically offset from one another.

Detailed Description Text (65):
Yet another method for filtering data is to screen data received from particular users and/or classes of devices which are capable of functioning as user stations. For example, it may be desirable to exclude traffic data received from buses, because buses do not provide representative velocity data due to frequent stops. Thus all data from buses could be excluded. Alternatively, data from particular types of user stations could be excluded. For example, the computer system 40 could maintain a database of the particular types of devices used by different users. Because data from hand held devices may not correspond to a vehicle moving along a road, the computer system 40 may reject data from the class of hand held computing devices. Thus the system could distinguish between different classes of users and/or user stations 52 to

determine whether to accept traffic data from that user station.

Detailed Description Text (66):
In another embodiment, the present inventors came to the realization that merely encoding the image with a representation of the traffic flow relative to a single fixed value is not optimal. An example of such coding would be red is 0-30 mph, yellow is 30-40 mph, and green is 40+ mph. This coding is adequate for freeways but when roads are encoded that have lower speed limits, the encoding should be relative to what the speed limit is so that the user knows the relative speed of traffic on the road. Thus coding may correspond to relative speed rather than absolute speed. For example, a freeway with speed limit 55 mph would be coded 0-30 mph red, 30-40 mph yellow and 40+ mph green, while a side road with a 35 mph speed limit would be coded 0-20 mph red, 20-25 mph yellow and 25+ mph green. This permits relative encoding which is easier to interpret. Alternatively, encoding may be based on other relative measures, such as for example, anticipated traffic flow for that particular road, section of road, time of day, and statistical history measure of traffic in the past. When multiple freeways in the area are all busy, such as Seattle, coding for absolute values may show everything as red. However, if relative coding is used, the traffic flow may be relative to other roads so that the encoding dynamically adjusts to encode one road relative to one or more other roads. In this manner, for example, the "fast" road may be green and the "slow" road may be red.

Detailed Description Text (67):
While the present invention has been described in the context of providing traffic information, the present invention may also be used to provide location specific information to mobile users. In one such embodiment, an information database may be created for weather reports, in which various weather reports are associated with respective geographic locations. A user in a vehicle 60 may request a weather report from the mobile user station 52. The request would include the user's geographic location as determined by the GPS receiver 62. In response to the request, the computer system would access the weather database and select the weather report associated with that geographic location. The location specific weather report would then be transmitted to the mobile user station 52. The weather report would then be displayed or otherwise communicated to the user through speakers. Other similar information databases could likewise be prepared to associate particular information with geographic locations. In this manner, a user at a mobile user station 52 may easily obtain highly relevant information that is specific to the location of the user. In preferred embodiments of the system, the user may receive both traffic information and other location specific information at the same time, in sequence, or as requested by the user. In one such embodiment, the user may preselect the information to be retrieved and the sequence of display or communication.

CLAIMS:

1. A system for providing traffic information to a plurality of mobile users connected to a network, comprising: (a) a plurality of traffic monitors, each said traffic monitor comprising at least a detector and a transmitter, said detector providing a signal including data representative of vehicular movement and said transmitter transmitting said signals; (b) a receiver, remotely located from said transmitter, that receives said signals transmitted by said traffic monitors; and (c) a computer system interconnected with said receiver and said network; (d) a mobile user station connected to a global positioning system receiver, a display, and a communicating device; and (e) said computer system, in response to a request for traffic information from one of said mobile user stations, providing in response thereto to said one of said mobile user stations traffic information representative of said signals transmitted by said traffic monitors; (f) wherein said traffic information transmitted by said computer system is displayed graphically on said display; and (g) wherein said computer system has a map database, and said computer system, in response to said request for information, transmits map information representative of a portion of said map database, and said map information representative of said map database is displayed graphically together with said traffic information.

10. The system of claim 1 wherein said computer system selects said traffic information to provide to said mobile user station based on a signal received from said global positioning system receiver.

11. The system of claim 10 wherein said computer system maintains a traffic information database containing data representative of traffic at a plurality of locations and updates said traffic information database in response to signals received from said mobile user station.

12. The system of claim 11 wherein said mobile user station displays both the location of said mobile user station and traffic information graphically on said display.

13. The system of claim 12 wherein said mobile user station has an input mechanism to select a mode in which traffic information is shown on said display.

14. A system for providing traffic information to a plurality of mobile users connected to a network, comprising: (a) a plurality of vehicles, each said vehicle comprising at least a mobile user station, a global positioning system receiver and a transmitter, said mobile user station providing a signal including data representative of a location of said mobile user station and at least one of a speed of said vehicle and an identification code of said mobile user station and said transmitter transmitting said signal; (b) a receiver that receives said signals transmitted by said user stations; and (c) a computer system interconnected with said receiver and said network, said computer system, in response to a request for information from one of said mobile user stations, providing in response thereto to said one of said mobile user stations information representative of said signals transmitted by said mobile user stations; (d) wherein said vehicle further comprises a display and said information transmitted by said computer system is displayed graphically on said display; and (e) wherein said computer system has a map database, and said computer system, in response to said request for information, transmits information representative of a portion of said map database, and said information representative of said map database is displayed graphically.

16. The system of claim 15 wherein said computer system screens data provided by said mobile user stations to determine before updating said traffic information database.

17. The system of claim 14 wherein the location of said one of said mobile user stations is displayed graphically on said display together with said traffic information provided by said computer system.

20. The system of claim 14 wherein said mobile user station has an input mechanism to select different modes of displaying traffic information on said display.

21. A system for providing traffic information to a plurality of mobile users connected to a network, comprising: (a) a plurality of mobile user stations, each mobile user station being associated with a display, a global positioning system receiver and a communicating device to allow each of said mobile user stations to send and receive signals; (b) a computer system interconnected with another communicating device and a network, said computer system being capable of sending and receiving signals to and from said mobile user stations; (c) said computer system including a map database and a traffic information database, said traffic information database containing data representative of traffic at a plurality of locations; (d) at least one of said mobile user stations providing a request to said computer system for information together with a respective geographic location of said one of said mobile user stations, and in response thereto, said computer system providing to said one of said mobile user stations information representative of selected portions of said map database and selected portions of said traffic information database based on said respective geographic location of said one of said mobile user stations; and (e) said one of said mobile user stations displaying graphically on said display information representative of said selected portions of said map database and said selected portions of said traffic information database.

23. The system of claim 22 wherein said computer system updates said traffic information database based on data received from said mobile user stations.

24. The system of claim 23 wherein said computer system compares data from said mobile user stations with said data derived from said traffic monitors before updating said traffic information database.

25. The system of claim 21 wherein said computer system updates said traffic information database based on data received from said mobile user stations.

28. The system of claim 27 wherein each said mobile user station provides longitude and latitude information to said computer system.

30. The system of claim 21 wherein said mobile user stations each have an input mechanism for selecting the mode of displaying information on said display.

31. The system of claim 21 wherein said location of said one of said mobile user stations is displayed graphically.

32. The system of claim 31 wherein said displayed location of said one of said mobile user stations changes based on movement of said mobile user station.

33. The system of claim 21 wherein said computer system screens data provided by said mobile user stations to determine whether said data corresponds to actual traffic conditions.

34. The system of claim 21 wherein said computer system compares data provided from said one of said mobile user stations with said map database before updating said traffic information database.

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DOCUMENT-IDENTIFIER: US 6515595 B1
TITLE: Personal communication and positioning system

Abstract Text (1):
A location tagged data provision and display system. A personal communication device (PCD) with electromagnetic communication capability has a GPS receiver and a display. The PCD requests maps and location tagged data from data providers and other for display on the PCD. The data providers respond to requests by using searching and sorting schemes to interrogate data bases and then automatically transmitting data responsive to the requests to the requesting PCD.

Brief Summary Text (4):
Availability of up-to-date information is more important today than ever before and this will continue to be true for the foreseeable future. People want to be well informed, so much so that they travel with cellular phones, beepers, and even portable hand-held Global Positioning System (GPS) satellite receivers.

Brief Summary Text (5):
GPS capable devices generally have a GPS receiver for receiving satellite signals from the GPS satellite network that allow for determination of the device's position. Such devices allow for precisely locating the device in terms of latitude and longitude using the GPS receiver. Some devices have map data stored in memory and a display for showing the device position with reference to the map data. Other devices have no underlying map data base for reference. Rather, they show only the geographic. coordinates of the device's location. These coordinates may be referred to as waypoints. Most GPS receiver devices can store many waypoints. Some GPS receiver devices can plot and display a trail of waypoints and store this trail for future retrieval. Sophisticated devices may compute the device's heading, speed, and other information based on comparisons with previous GPS determined positions.

Brief Summary Text (6):
GPS receiver devices with map display capability may store the map information on computer diskettes, CD-ROM's, or other computer memory storage devices. The device location may then be displayed on a display terminal with reference to a map stored in the computer memory storage device. The available quantity of map data, however, can overwhelm the memory capability of easily portable computer devices. This problem is exacerbated when additional information is included and linked with the map data. In addition, information is more valuable when it is up to date and available at the time of consumption, and such devices do not incorporate a means for updating the stored information. By way of example, a CD ROM could never maintain an up-to-date list of every 5-star restaurant.

Brief Summary Text (7):
Some GPS receiver devices have the ability to communicate over a telecommunications network. These devices do not provide for automatic or semi-automatic dynamic exchange of on-line position dependent or related information. In addition, these devices cannot communicate with third parties in the absence of a uniform data format standard. For example, a cellular-phone-based system comprising GPS location information working in conjunction with proprietary Public Safety Answering Point (PSAP) telephone equipment is known. The device provides personal and medical information on an emergency basis to the proper authorities. Such a device does not allow third parties to communicate, tag, interrogate, limit, designate, modify or

share this information amongst themselves for any other use.

Brief Summary Text (8):
To that end, the ability to receive digital data structures with GPS encoding, and storing this information for eventual use or broadcast to third parties, would be valuable. Today, the U.S. and several other countries have independent publishers busily GPS mapping everything down to the most minute detail. Most of these data bases are available on CD ROM storage. The problem is that no one data base can contain enough information to fulfill the unique requests of every particular and picky consumer. The costs associated with providing and maintaining such a large data base would be overwhelming and over-burdening. Additionally, most consumers do not like reading or compiling vast data bases.

Brief Summary Text (10):
The system of the present invention utilizes Personal Communications Devices (PCDs), and traditional computer systems with GPS engines, routers, and other application programs to request, process, and transmit tagged GPS encoded information. The system, with related applications, can be accessed by device users, traditional computer users, web-site users (cyberspace), data publishers, public or private enterprises or individuals, by means of application programs. The tagged GPS encoded data files can be stored or sent via communication links using AM, FM, spread spectrum, microwave, laser or light beam in free or fiber optic, line-of-sight, reflected, satellite, secure or non-secure, or any type of communications between multiple points that the application or the state-of-the-art may allow. The system is a waypoint tag and interrogation system using various protocols to answer requests and provide GPS-encoded information. The applications use GPS devices, engines, routing and encoding for access to specific requester-designated data retrieval requests. The applications access fax machines, beepers, telephones and other communication linked devices. The system accesses computer and storage systems with various applications in order to provide this information from a plurality of providers. The system thereby eliminates or reduces the need for large storage devices and interchangeable storage modules.

Brief Summary Text (11):
One embodiment of the present invention includes a requesting device, a data provider (hardware and software), a user, tagger applications or GPS engine and router system with protocols for encoding, tagging, modifying, interrogating, arranging, limiting, displaying, sorting, mapping, segregating, sending, receiving and updating waypoint and the waypoints connected data structures with digital or graphic maps, digital voice files, linked digital web files properly encoded and tagged by way of specific devices, or by traditional computer and storage systems.

Brief Summary Text (12):
The application programs contain protocols for users, providers, taggers, list maintenance organizations, and others, and will use a dynamic identification system from applications containing GPS search engines, route planners, compilers, designators, publishers, and others to permit communication of information.

Brief Summary Text (13):
The PCD is a cellular-phone-sized electronic device, combining the capabilities of a GPS receiver, transceiver, digital beeper, cell phone and projection system into one compact unit. The PCD is capable of uploading emergency information (medical, police alert, etc.) via a one-push button that phones 911 or a security monitoring center similar to those used for house alarms. The alert continues to be broadcast until a response is made.

Brief Summary Text (14):
The PCD is also capable of downloading information via a request to a data provider, similar to a request for directory information from a phone company or other service. In this mode the PCD acts similar to calling a phone operator for information. However, in this instance, no human contact is required. The caller requests specific information (location of gas stations, names of restaurants, local banks, etc.) via a voice command ("Download e.g., Wells Fargo Banks") or via digital commands using a keypad or other input device and the requested information is automatically downloaded to and stored in the memory of the user's PCD. This information can be accessed

off-line via the screen on the PCD. It is all done digitally, eliminating having to write down information such as name, address, location map, GPS latitude and longitude encoding, direction and distance to location, hours of operation, or other items of information. The PCD can be plugged into an automobile input port or similar device, if available, and provide distances and directions to locations of interest. Similar information of a condensed nature can also be provided to the user via the screen of the PCD. The user is not required to be a subscriber to some proprietary system, instead the PCD can use any means to access any data base from any potential provider, whether GPS encoded or not.

Brief Summary Text (15):
In some areas the information would be sent and received by way of a Local Area Broadcast via radio frequency signals to each home, car or PCD within a reception area. In such an embodiment, users are able to access companies listed on the broadcast network from data providers of properly tagged, yellow page-type information or are provided with GPS encoded information and maps similar to web page listings. This would be advantageous to small towns with little information available for travelers, but which have an interest in providing up-to-date traffic, weather and travel advisories to benefit the local community and businesses. Such a system does not require a master, home or base unit. The providers of data base or advertising information could be a single data provider and could also be individual users with application programs that allow provision of such data. The application programs provide a means for sending and receiving data, GPS encoded data and graphics encoded data. The application programs can also act as a universal coder/decoder to other proprietary GPS data bases.

Brief Summary Text (16):
The present invention allows users to request detailed information relating to their present location as well as information related to distant locales. Some of the advantages provided by the invention include: 1. Information can be received digitally by a PCD user from any system. 2. Multiple requests can be retained, stored or resent. 3. In-depth dynamic data retrievals are possible and could be viewed later. 4. GPS tagging and encoding with latitude and longitude information along with encoded maps for navigation. 5. Small non-contiguous map segments are possible. 6. On-line storage of data personal and other information, along with GPS encoded maps on some data files. 7. Display menus, interfaces and applications can be viewed on heads-up display systems in automobiles, homes, businesses and various commercial applications. 8. Allows for portable Internet access. 9. Provides a means for an Internet based telephone directory access tagged and linked to the originating area code and phone numbers.

Brief Summary Text (17):
Remote and distant third parties could communicate with each other and, by sending and receiving GPS encoded data, can meet or find each other in remote locations. Maps and other digital data may be transmitted/received by fax, beeper (receive only), computer, phone and radio.

Brief Summary Text (18):
The system also utilizes a system of non-subscribers communicating to each other in a similar fashion, without the use of base stations. In addition, the non-subscribers could send personal data bases with maps included, GPS information, and other information of non-related data or graphics from publishers of any such data base. In this embodiment the device would act as a transceiver, sending and receiving dynamic moving waypoint information in digital formats, including maps of various sizes and embodiments.

Brief Summary Text (20):
An embodiment of this invention incorporates a GPS transceiver with a designated application used with a communication system or network. Several users can communicate and send data, maps and graphic files with or without GPS encoding. By example, a user could request from sensing, weather, or condition reporting devices details concerning remote locations. These sensing, weather, and condition reporting devices may also be accessible over cable land lines or other communication media.

Brief Summary Text (21):

In one embodiment of the device and tagging system information is communicated from locations, homes, businesses, commercial designations, government resources, public and private areas, cyberspace and other communication systems. Various designated locations, or a plurality and multiplicity of locations, or data structures, are assigned as waypoints. These waypoints could be tagged, or interrogated from an application program which describes, encodes, reports, modifies and communicates this encoded information and data from any location. In addition, the transmitting device may report a plurality and multiplicity of locations or events unrelated to either the location of either the transmitting or receiving device. Indeed, the device could communicate to many unlinked, unreported or unconnected waypoints and send active dynamic information to the requester. Cyberspace providers may enter the network web system, use applications for device communications and participate in the exchange of information using designated GPS engines and applications. By way of example, the invention can provide a requester with dynamic location information, or other data to a location anywhere in the U.S. This location information may be used to locate individuals in determining whether to authorize credit requests, whether PCD or item containing a PCD, such as an automobile, is moved, or in routing electronic communications.

Brief Summary Text (22):
The system is similar to the world wide web, except the web does not use GPS engines, applications, tagging systems, etc. By way of example, one difference is that the invention uses GPS devices, engines, applications and encoding for access to specific requester designated data retrieval techniques. Indeed, the invention provides a means to locate specific individuals both physically and in terms of an electronically accessible location.

Drawing Description Text (2):
FIG. 1 illustrates a GPS transceiver system and communication links incorporating the present invention;

Drawing Description Text (9):
FIG. 5C illustrates a flow chart depicting the program sequence for the user to control the GPS mode of the PCD of FIG. 2;

Drawing Description Text (14):
FIG. 7 illustrates the select GPS Function page of the PCD of FIG. 2;

Drawing Description Text (15):
FIG. 8 illustrates the GPS: Location page of the PCD of FIG. 2;

Drawing Description Text (16):
FIG. 9 illustrates the GPS: Show Me page of the PCD of FIG. 2;

Drawing Description Text (17):
FIG. 10 illustrates the GPS: Get Map page of the PCD of FIG. 2;

Drawing Description Text (18):
FIG. 11 illustrates the GPS: Third Party page of the PCD of FIG. 2;

Drawing Description Text (28):
FIG. 21 illustrates a typical GPS encoded map downloaded from a data provider;

Drawing Description Text (29):
FIG. 22 illustrates a typical GPS encoded map with waypoints locating restaurants within a specified radius;

Drawing Description Text (36):
FIG. 28 illustrates a software module configuration of the GPS engine;

Detailed Description Text (2):
FIG. 1 shows a system capable of communicating using the electromagnetic energy spectrum, traditional computer networks, cellular phone networks, public telephone networks, and satellite system networks. The major components of the system comprises personal communication devices (PCDs) 20 and one or more of the following: a cellular

phone network 60, a standard phone line network 70, an electromagnetic energy spectrum network 80 and/or a computer network 90. The PCD receives signals from a GPS satellite system 10.

Detailed Description Text (3):
FIG. 2 illustrates a PCD of the present invention. The PCD has a display 28a. The display may be of a LCD type or other types known in the art. Incorporated with the display is a touch screen input device 28b, which are known in the art. The PCD also has a alphanumeric key pad 26, which includes many of the standard keys generally found on computer keyboards. The location of the keys, and the selection of the characters used on a single key, may be varied as desired. The PCD also has specialized keys 27a-g, n related to GPS, telecommunications, and other functions. Located on one side of the PCD are a number of input and output ports. In the embodiment shown, these ports include a modem output port 29g, a generalized communication port 29f, a power port 35b, an infrared port 29e, and a heads-up display interface port 25k. The location of these ports are shown for descriptive purposes only, the specific location of these ports on the PCD is not critical. The power port allows the PCD to be operated from an external power source (not shown). The communication port allows the PCD to be connected to printers, local computer networks, and the like.

Detailed Description Text (6):
All known verbal commands from GPS systems can be implemented and attachment or inclusion of voice activation for map instructions relative to location, GPS and street designations, including heading descriptions, distance, and arrival time estimates can be included.

Detailed Description Text (7):
FIG. 24 illustrates a block diagram of the PCD's software components. An application module or program 51 interfaces with the PCD's operating system 241. The operating system may be DOS, UNIX, Windows 95, Windows NT, O/S2 Apple McIntosh, Next Computer, or other operating systems, including operating systems well suited to devices with constrained memory or other limitations due to the small physical size of the PCD. The operating system additionally interfaces with other application programs 242 that provide standard file edit and other functions typically found in personal computers. The operating system, or other application programs interfacing with the operating system, provide for maintenance of data bases 245 used by the PCD. The application module includes a GPS engine 53 providing GPS functions, including interfacing with the GPS receiver 243 (shown in FIG. 4). A query menu program 54 of the application module controls the graphical user interface and related functions for the device. Included in the application module is a universal converter 55.

Detailed Description Text (10):
FIG. 4A shows the top level page menu display hierarchy of the PCD. At initial power on the initialization page 25a (shown in FIG. 2) is displayed. The initialization page allows for the entry of a personal identification number and other data. Depressing the home button 27E (shown in FIG. 2) displays the Main Menu page 25b. A number of additional pages are available from the Main Menu page. These include the GPS 25c, Fax 25d, Beeper 25e, Phone 25f, Computer 25g, Radio 25h, Send Queue 25i, and Receive Queue 25j pages.

Detailed Description Text (13):
In addition, the Initialization page 100FIG. 2, as well as all other pages, displays the time and the date 103, touch points for QUE IN 550 and OUT 600 (described later in this document) and limited GPS information 107. The limited GPS information comprises of the user's location (latitude and longitude), an arrow pointing to north and an arrow indicating direction of device travel.

Detailed Description Text (14):
When enabled, pressing the HOME button 27e (FIG. 2) signals the processor to display the Main Menu page 150 FIG. 5B. As shown in FIG. 6, the Main Menu page allows the operator to use the touch screen to select the GPS 200, FAX 300, BEEPER 350, PHONE 400, COMPUTER 450, RADIO 500, RECEIVE QUE 550 and SEND QUE 600 touchpoints. The heading and directional information are displayed in real time and are dynamic. Pressing the FAX touchpoint causes the processor to display a Fax page (shown in FIG.

12) which lists received facsimile messages 301. The Fax page includes display interfaces appropriate for the sending and receiving of facsimile communications through the FAX Phone Modem port 29g, and such displays and functions are well known in the art. Pressing the BEEPER touchpoint causes the processor to display a Beeper page (shown in FIG. 13). The Beeper page displays received beeper messages 351 and allows for the deletion of such messages from the display and internal memory storage. Also, a sub-menu portion of the display 151 is reserved for sub-menus and directories.

Detailed Description Text (15):
Pressing GPS 200 causes the processor 21 to display a GPS Function page 201, which is illustrated in FIG. 7. The GPS page provides for selection of a GPS mode through touch points in the sub-menu portion of the display. The available modes are location 210, show me 230, get map 250 and third party 270 modes. The display returns to the GPS Function page when the PREVIOUS button 27i (shown in FIG. 2) is pressed. The display hierarchy for the GPS functions is illustrated in FIG. 5C. The Location, Show Me, Get Map, and Third Party pages descend from the GPS Menu page. The Location page comprises the current map, the location on the map of the device, and a plot of the trail of the device on the map. The sub-menu portion of the display provides for additional selection of still further pages. These pages include a Menu page, a Mode page, a Waypoint page, and a Preferences page.

Detailed Description Text (16):
The Location page is illustrated in FIG. 8. The Location page includes a GPS map 219 (latitude and longitude encoded coordinate pairs). The sample page shown is an encoded map showing the device position, plot trail and the encoded map location of the selected waypoint. The map displayed could be from on-board memory or sent by other third parties by way of communication links to the PCD. When map data files are encoded with location information, the location information can be referred to as waypoints. These tagged waypoints, with links to other data structures, can then be sent to users via an application to various communication systems. Closed-loop or proprietary GPS receivers can send/receive data to/from other third parties (Brand X, Brand Y) via their own proprietary format using an application system as a universal converter. The location information is dynamic and updated periodically by the PCD's communication system via link-up with GPS-based satellites. The Location page indicates the PCD position 801, indicated by a walking person, as being located on a highway 810. A waypoint 802 is along the highway en route to the desired destination address 803 located on a local street 804 which intersects the highway. A first point of interest 807 is also displayed as being along the highway, as is a second point of interest 805 along a second local road intersecting the highway. The limited GPS information, providing location, heading and north, is also displayed. The illustrated Location page display shows only one possible combination of a map layout. Other display sequences such as North up, course up, user at top of screen, user in middle, and other display sequences are possible. The dynamic nature of the PCD allows the PCD to display GPS encoded maps as the PCD progresses dynamically with relation to the maps.

Detailed Description Text (17):
Using interpolation techniques, performing spatial query analysis, and establishing layers for best display scale for any given map record allows the device to provide the user extended capability not possessed by traditional GPS devices. Applying various protocols and interpolation techniques allow files to be arranged geographically by distance from a designated point (usually the requesters latitude and longitude as the starting point, but other locations may also be used). The maps are also arranged in layers, menus, limited, listed, showed, displayed, and sorted.

Detailed Description Text (18):
The Location mode provides typical GPS system functions. The touch points MENU 213, MODE 215 and WAYPOINT 217 and PREFERENCES 221 provide access to the Menu, Mode, Waypoint, and Preferences pages. These pages, along with various buttons on the alphanumeric key pad 26FIGS. 2 and 4 and special function buttons 27, are used to configure the display to the user's preference. The preferences page 221 enables selection of such features as voice, maps, scroll, off screen maps away from cursor and other features. The listing name 219 portion of the Location page displays information pertaining to a waypoint selected through the use of the cursor.

Detailed Description Text (19):
FIG. 9 illustrates the Show Me page accessed from the GPS page. The Show Me page shows a list of available maps 901a-i stored on-board, which includes maps retrieved from the receive queue area of the PCD memory. The user can load a map into the location or third party pages by pressing the corresponding number key on alphanumeric key pad 26 (shown in FIG. 2) or by scrolling through the list to highlight the appropriate map and then pressing ENTER button 27g. Maps may also be removed from on-board storage using the DELETE button 27h.

Detailed Description Text (20):
FIG. 10 illustrates the Get Map page accessed from the GPS Menu page. The user of the PCD can request the map by location from PCD memory or an external source. The user may enter a desired map location. If a map location is entered, the PCD will only search PCD memory for a map for the entered location. Maps from an external source are downloaded via any of the communication links such as the FAX, BEEPER, PHONE or RADIO touchpoints provided in the sub-menu portion of the display 151. Depending on the user's requirements, several maps could exist showing similar map areas with different layers for viewing. By way of example, airport maps with air space requirements, coastal waterway, maps, and interstate maps, and even hand drawn maps scanned into a computer system all show different resources within a given geographic area. These maps, when presented on the PCD, could over-saturate the display map detail for any given map area. Therefore, it is preferred that the actual map displayed be selectable. Maps are retrieved by pressing QUE IN 550, scrolling to highlight the desired map, and pressing ENTER 27g FIG. 2.

Detailed Description Text (21):
FIG. 11 illustrates the Third Party page accessed from the GPS menu page. The Third Party page provides an interface to communications with a third party through touch points in the sub-menu display 151. In the display shown, a user can receive a third party's data and GPS encoded map for viewing on the device or save it for future usage. The user can also dynamically track the third party by periodically having the third party send updates via normal communication links. The third party location can be displayed on maps dynamically sent by map publishers, maps already on-board (furnished at some earlier date), or on maps sent by the third party. The PCD plots and interpolates the GPS data sent by the third party and places an icon 951 (GPS latitude and latitude coordinate pair) on the displayed map using spatial query analysis techniques performed by an application module. The information received from the third party may be other than maps or GPS encoded information, but may be information of any type. The data is received from the third party using phone 400 and radio communication links 500. A PREFERENCES touch point 274 enables entry of items such as phone numbers for automatic call back and time interval for automatic transmission of information. If the radio, a satellite phone, or other frequency based communications link is utilized, the PREFERENCES touch point allows entry of frequencies for use for automatic transmission of information. A split screen displays the user's location on a map on the left side of display 272 and, after contact with a third party via a communication link, the third party's map and location on the right side of display 273. If the third party's location is sufficiently close to the user's location, or if the user's displayed map covers a sufficiently large area, both the user's and third party's location can be shown on the same map without resort to a split screen display.

Detailed Description Text (22):
The Fax page is accessed by pressing the FAX touchpoint on the Main Menu page. FIG. 12 illustrates the Fax page. The sub-menu portion of the display is available for listing previously stored phone numbers. These phone numbers are selectable as a facsimile destination. In addition, the user can directly enter the phone number to indicate the facsimile destination. As with other pages, the PCD continues to dynamically display the limited GPS information of location, north and heading. The PCD facsimile function is performed by application software executed by the processor. Multiple fax locations, time set, send after certain time, and other traditional functions of fax machines and their implementation are well known in the art. The Fax page provides for display of a message (not shown) entered via the alphanumeric key pad 26 (shown in FIG. 2) or through selection of messages stored in the send queue area of device memory. Messages stored in the queue area of PCD memory can be selected by scrolling

through a directory 305 of all fax messages stored. To view a stored message the user uses the SCROLL button 27a (shown in FIG. 2) to highlight an entry, and then press ENTER button 27g. Pressing the SEND button 27b transmits the selected or entered facsimile. The user may also view received faxes using this mode by pressing QUE IN 550FIG. 12, using the SCROLL button 27a to highlight the desired message, and pressing the ENTER button 27g.

Detailed Description Text (24):
The Phone page is illustrated in FIG. 14. The Phone page is accessed from the Main Menu page. Pressing the PHONE touchpoint on the Main Menu page causes the processor to display the Phone page. The Phone page is also accessed by pressing the PHONE touchpoint on the Get Map and Third Party pages. As with the other pages, the limited GPS data is continuously displayed showing PCD location, heading, and north. The PCD can access several areas of the display even while the PCD is being used as a telephone. Information provided in the display area 1401 will vary depending upon the page from which the phone page was accessed. The Phone page provides for selection of a function through touch points displayed in the sub-menu portion of the display. The selectable touchpoints are: POLICE 403, MEDICAL 405, DATA PROVIDER 407, DIRECTORY 413, and MEMORY 415.

Detailed Description Text (28):
The primary data providers may include the public telephone company networks but may also include other entities. The data providers maintain data, including maps, telephone yellow page entries, and other information such as traffic and weather reports. This information is maintained in a timely manner and is accessible through the use of data base methods well known in those in the art. Upon receiving a request for data, the data provider determines the nature of the data request, searches the appropriate data base or data bases, and transmits the requested information to the requesting device in the manner specified by the requesting device. The user, after the PCD receives the data as requested, disconnects, goes off line to review the information, deleting some, saving others, and storing other encoded information on the PCD. The user can now further edit the device's entire data base and decide a sequence for navigating to the locations listed in the various menus as waypoints. Thus users of the PCD can decide to navigate using the GPS features of the PCD and select certain waypoints and the order in which to proceed. By way of example, but not limited to same, users could select gas stations, banks, restaurants, shopping centers in unfamiliar areas, navigate today from one point of beginning and tomorrow continue navigating from another point of beginning, being assured that the device will always know how to get to various locations. Should the user require further locations to visit, the PCD is capable of obtaining new navigational data and adding to the already active route plan without having to completely start over.

Detailed Description Text (30):
FIG. 16 illustrates the Computer page. The Computer page is accessed by pressing the COMPUTER touchpoint 450 (shown in FIG. 6) on the Main Menu page. The Computer page allows the user to operate the device as a standard personal computer utilizing application programs of the type normally present on personal computers. As examples, the display of FIG. 16 provides for touchpoints in the sub-menu portion of the display for calendar date entry, notes, and organizer application programs. As with the other pages, the limited GPS information is also displayed.

Detailed Description Text (31):
FIG. 17 illustrates the Radio page. The Radio page is accessed by pressing the RADIO touchpoint 500 on the Main Menu page. The radio mode provides the user with an interface for selecting the type of radio signal through touch points displayed in the sub-menu 151 area. The selectable types are: AM 503, FM 507 and TRANSCEIVER 511. Selecting any type will display a page (not shown) requesting frequency, volume, and other parameters relating to radio transmission and reception. The AM and FM are standard receivers. The device can thereby tune and listen to broadcasts that provide data links and receive data files using legal AM or FM radio bands (or any other radio band legal to access and provide radio station information). The device therefore allows users to communicate information amongst themselves without having to rely on telephone technology. This is especially valuable when telephone technology is not available.

Detailed Description Text (32):
The Receive Queue page displays stored received messages. The received messages may be displayed by reception type through selection of the transmission line type listed in the sub-menu portion of the display, the selectable types, through touch points displayed in the sub-menu 151 area, are: ALL 553, FAX 555, BEEPER 557, PHONE 559, COMPUTER 561 and RADIO 563. Selecting a type, will sort (by specified type) and display (by date and time) all messages received. By way of example, the radio queue contains GPS-encoded voice mail or digital files (containing information to various sites) provided by private third-party sources. The phone system queue contains previous calls with digital messages linked to web pages containing voice and video data. The computer which may be queued contains personal letters, calendars, notes and the like from more traditional sources or user created tagged files for storage. The fax queue contains traditional faxes which may illustrate maps with waypoints. The beeper mode queue contains received beeper messages (digital and voice).

Detailed Description Text (35):
As shown in FIG. 23B, the application module of the device is ported to a computer system not GPS capable, or merely not portable so as to have no need for a GPS receiver. The application module allows non-PCD based computer users to provide data to the data provider in the correct format, as well as receive data from devices or the data provider. This allows the non-device base computer user to track the location of devices and to collect information to be manually entered into a traditional GPS capable device as an aid in future trip planning.

Detailed Description Text (36):
FIG. 20 illustrates a list of GPS encoded data for a restaurant listing of restaurants in a requested area. This list may have been furnished by third parties or a data provider. The PCD has stored this information in digital format and is displayed on a GEO coded map, GIFF map or any other map the PCD stored in memory or receives from a third party or data provider. The information can be arranged by the PCD using criteria enabling the user unlimited access to the data. If the user chooses to navigate to these locations singularly or as a group, the GPS engine performs these functions, allowing a user of the device to accurately travel to the desired restaurant. As shown in FIG. 21, the PCD can use any scale of map or combinations and other types of maps as shown. The user of the PCD selects certain maps for storage and recalls same when needed for navigation. By way of example, the user's device could have a local Los Angeles street map, an interstate map (as shown in FIG. 21), and a New York city map in device memory. The user could navigate to the airport using the GPS functions and stored Los Angeles map, fly to New Jersey, rent a car and navigate to New York using the interstate map and, finally, find a specific restaurant in New York City by using the third map stored in PCD memory.

Detailed Description Text (38):
Using the map of FIG. 22, the user could navigate to a school, restaurant, bank, gas station, government office using the PCD to interpolate using spatial query techniques to find the best routes to each location. The PCD can re-collate the list for the most efficient route using the application and GPS engine modules. Using software programing techniques and math formulas, persons skilled in the arts will utilize spatial analysis queries and functions to determine best routing and "closest to" scenarios. In addition, centroid interpolation functions and match-rate comparison functions used by the GEO coding community will further enhance this application's ability to universally communicate with other systems.

Detailed Description Text (45):
FIG. 34 illustrates a block diagram of the condition reporting device (CRD). The CRD includes a processor 1200, memory 1202, a battery 1204, a speed detector 1206, a digital camera 1208, a radio transceiver 1210, an antenna 1212, a coaxial cable port 1214, and sensors 1216. The memory stores data pertaining to operation of the CRD, including instructions for execution by the processor which controls operation of the CRD. Specifically, the processor reads data from the various sensors and transmits data via the transceiver. In one embodiment the memory additionally stores data pertaining to normal expected conditions, such as normal temperatures or traffic flow, at the CRD location. This data could take the form of merely the average normal temperature at the site, but more preferably provides daily or hourly normal temperatures and hourly traffic pattern information.

Detailed Description Text (69):
Thus, in either the automatic hand-off mode or the automatic sequence mode, the user may have a PCD in his automobile and be automatically informed of current road conditions along the expected route. If road conditions are reported as unpassable due to weather or traffic, then the user may appropriately plan to take alternate routes.

Detailed Description Text (73):
Condition reporting devices 1308a-j are located at various points along the streets and highways. The condition reporting devices provide traffic speed and weather indications through the PCD via methods discussed above. The map information made available to the PCD and stored by the PCD contains distance information. The PCD therefore is able to make use of the traffic speed information and the distance information to determine travel times for the various route and route alternative segments. Real time calculation and display of segment travel times accordingly allows the PCD user to accurately determine and estimate travel times to particular destinations over a plurality of different roads and road segments.

Detailed Description Text (75):
FIG. 44 illustrates a block diagram of a local area transmission system for providing multimedia information using GPS navigation system coordinates. Data 1330 pertaining to a local geographic area is maintained by cellular telephone system providers or other entities. The particular local geographic locations are based on the locations of cell sites for cellular telephone networks, and the location specific data is transmitted by a cell site 1332 both over a standard radio broadcast system using a radio transmitter 1334 and by request to the cell site via a telephone access number. This data includes ASCII or other text formats, digital graphical images, including maps, digital photo-based images, and audio data.

Detailed Description Text (76):
In the radio broadcast system method of transmitting data, a first radio frequency is used to inform receivers of the radio broadcast of specific frequencies to be used to obtain particular types of data. The specific frequencies continually transmit data pertaining to services and information of the type specified for the particular frequency. The data includes text and graphics normally including names, addresses, phone numbers and GPS locational information for providers of the services of the type for that frequency. Additionally, digital GPS maps for the particular cell site broadcast location are also included.

Detailed Description Text (77):
Similarly, each cell site location is provided a specific telephone number. Users of cellular telephone-capable devices call the number and are in turn provided a list of telephone numbers for providing data equivalent to the data provided by the radio broadcast system. Two sets of phone numbers are provided. The first set provides voice audio information, and the second set provides information in digital form. In one embodiment, users of a PCD then direct the PCD device to obtain digital text, graphical maps, and GPS location information from the cell site telephone number. This information may then be used by the user of the PCD device to determine route information and to obtain data in the same manner as from other GPS tagged data providers.

Detailed Description Text (82):
The PCD also serves as a position monitoring device. To begin the position monitoring function the user selects the monitor on the PCD. Upon selecting the monitor function, the PCD displays a menu including INTERROG, AUTO-TIMED, and MOVE options. When the INTERROG function is selected the PCD will display an e-mail entry field allowing input by the user of an e-mail address. After the e-mail address is entered, the PCD responds to appropriate interrogatories by transmitting its current position. An appropriate interrogatory includes the security code active when the INTERROG mode was selected and an Internet e-mail address. Upon receipt of an appropriate interrogatory the PCD will transmit the GPS receiver determined latitude and longitude of the device to the e-mail address.

Detailed Description Text (84):
When a user selects the MOVE option the PCD displays a distance entry field and an

e-mail address entry field. After entry of the distance field and the e-mail address field, the PCD transmits an e-mail containing the device location to the e-mail address specified in the e-mail field whenever the PCD moves a distance greater than the distance entered in the distance field. When the PCD transmits an e-mail indicating the device position, the current device position is stored and the PCD waits until the device has moved the distance specified in the distance field from the current location prior to again transmitting the PCD location to the e-mail address specified in the e-mail address field.

Detailed Description Text (85):
Thus, the PCD can be used to monitor the locations of individuals utilizing PCDs. For example, credit authorization agencies may make use of the location monitoring capability provided by the PCD in determining the validity of credit requests. FIG. 46 illustrates a method of credit authorization using the PCD. In step 1360 an individual makes a request for credit. This may be accomplished in a variety of manners, including "swiping" a credit card through a credit card reader at a gas station, supermarket, or a variety of other locations, or merely by providing a credit card to a retail clerk who thereafter requests credit authorization. The request for credit may be made to a credit card issuer, or may merely be a request for credit authorization by a credit reporting facility.

Other Reference Publication (7):
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Other Reference Publication (8):
Yamaguchi, Jack, "Honda In-Car Navigation System for the U.S.", Automotive Engineering, Jun. 1996 (pages 82-84).

Other Reference Publication (11):
Jewett, Dale, "Toyota Offers Navigation System as U.S. Option", Automotive News, Nov. 18, 1996 (page 16, 2 pages).

Other Reference Publication (18):
Dye, Steve, et al., "The GPS Manual Principles and Applications", Baylin Publications, Feb. 1997 (23 pages, incomplete manual).

CLAIMS:

1. A locating and map downloading system comprising: a personal digital communicator comprising: a display; a receiver for receiving GPS signals; a first transceiver; a first modem coupled to the transceiver and to a first digital processor; communicator input means for formatting a request for map information; the first digital processor providing a means for processing the GPS signals and determining therefrom the location of the communicator, for transmitting via the first modem and the first transceiver the request for map information, for displaying on the display map information responsive to the request, and for displaying on the display the communicator location with reference to the map information; and a map storage and transmitting device comprising a second transceiver, a second modem coupled to the second transceiver and a second digital processor, memory for storing map information in digital form, the second digital processor providing a means for determining which map information stored in the memory is responsive to the request and transmitting via the second modem and the second transceiver the map information responsive to the request; the map storage and transmitting device memory stores additionally stored data associated with discrete data points within the map information and such additionally stored data is transmitted with the responsive map information; and a condition reporting device comprising: a processor; a computer memory storing information, the computer memory being accessible by the processor and containing at least location identification information; at least one weather condition sensor providing external information to the processor, the processor storing the external information in the computer memory; a vehicular traffic condition sensor providing vehicular traffic information to the processor, the processor storing the vehicular traffic information in the computer memory; and output means for transmitting information in the computer memory to the map storage and transmitting device; wherein the first processor determines a route to a selected marker; and wherein the first

processor transmits via the first modem and the first transceiver the location of the selected marker and a request for locations of condition reporting devices within a predefined distance of the selected marker.

8. A process for using route information stored by a personal digital communicator to obtain information regarding availability of condition reporting devices along a route from a central computer system using a locating and map downloading system that requests the route information including detailed traffic information relating to a location along a route and detailed weather information relating to the location along the route wherein the process comprises: providing a personal digital communicator comprising a display, a receiver for receiving GPS signals, a transceiver, a communicator input means for inputting a destination and a map storage and transmitting device; providing the condition reporting device comprising a processor, a computer memory accessible by the processor and containing at least location identification information, at least one sensor providing external information to the processor wherein the processor stores the external information in the computer memory and determines the route to a destination and a request for locations of the condition reporting devices within a predefined distance of the destination and an output means for transmitting information in the computer memory to the map storage and transmitting device; transmitting, via the personal digital communicator, a request for condition reporting device locations to the central computer system wherein the central computer determines locations of the condition reporting devices along the route and transmits via the transceiver the locations of the condition reporting devices to the personal digital communicator; and correlating, via the personal digital communicator, the condition reporting device locations to the route information and forming a map display indicating a trail plot and the condition reporting device locations.

10. A process for obtaining condition reporting information from condition reporting devices using an automatic hand-off method using a locating and map downloading system that requests the condition reporting information including detailed traffic information relating to a location along a route and detailed weather information relating to the location along the route wherein the process comprises: providing a personal digital communicator for maintaining a sequential list of the condition reporting devices wherein the personal digital communicator comprises a display, a transceiver, a communicator input means for inputting a destination and a map storage and transmitting device; and determining an order of the condition reporting devices along the route wherein the condition reporting devices comprise a processor, a computer memory accessible by the processor and containing at least location identification information, at least one sensor providing external information to the processor wherein the processor stores the external information in the computer memory and determines the route to a destination and a request for locations of the condition reporting devices within a predefined distance of the destination and an output means for transmitting information in the computer memory to the map storage and transmitting device; displaying the condition reporting device information of the first condition reporting device encountered by the personal digital communicator on the personal digital communicator; determining if the condition reporting device is within a predetermined distance of the personal digital communicator and requires removal from the sequential list; and displaying the condition reporting device information of the next condition reporting device encountered by the personal digital communicator on the personal digital communicator.

11. A locating and map downloading system comprising: a personal digital communicator comprising: a display; a receiver for receiving GPS signals; a first transceiver; communicator input means for formatting a request for map information; a first digital processor for transmitting via the first transceiver the request for map information; and a map storage and transmitting device comprising a second transceiver, a second digital processor and a memory for storing information in digital form; and a condition reporting device comprising: a processor; a computer memory accessible by the processor and containing at least location identification information; at least one weather condition sensor providing external information to the processor, the processor storing the external information in the computer memory; a vehicular traffic condition sensor providing vehicular traffic information to the processor, the processor storing the vehicular traffic information in the computer memory; and output means for transmitting information in the computer memory to the map storage and

transmitting device; wherein the first processor determines a route to a selected marker; and wherein the first processor transmits via the first transceiver the location of the selected marker and a request for locations of condition reporting devices within a predefined distance of the selected marker.

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DOCUMENT-IDENTIFIER: US 5504482 A
TITLE: Automobile navigation guidance, control and safety system

Abstract Text (1):
An automobile is equipped with an inertial measuring unit, an RF GPS satellite navigation unit and a local area digitized street map system for precise electronic positioning and route guidance between departures and arrivals, is equipped with RF receivers to monitor updated traffic condition information for dynamic rerouting guidance with a resulting reduction in travel time, traffic congestion and pollution emissions, is also equipped with vehicular superceding controls substantially activated during unstable vehicular conditions sensed by the inertial measuring unit to improve the safe operation of the automobile so as to reduce vehicular accidents, and is further equipped with telecommunications through which emergency care providers are automatically notified of the precise location of the automobile in the case of an accident so as to improve the response time of road-side emergency care.

Brief Summary Text (2):
The present invention relates to inertial navigation, automobile control, three dimensional satellite positioning, vehicular traffic management, automobile telecommunications, automobile radio data systems, traffic monitoring systems, local area digitized traffic maps, route guidance systems, road side emergency care and pollution control. More specifically, the present invention relates to integrating, adapting and improving various technologies and methods to provide a comprehensive vehicular route guidance, control and safety system for reducing travel time, pollution emissions, traffic accidents and road side emergency care response time.

Brief Summary Text (4):
Modern automobile travel has long been plagued by excessive traffic congestion and resulting air pollution from continually increasing automobile use. Drivers have long sought optimum travel routes to minimize drive time, and governmental agencies have sought to reduce air pollutants, as is well known. Local area radio and TV stations have transmitted "sig-alerts" to inform drivers of blocked or congested traffic routes so that drivers familiar with various routes to their respective destinations can alter enroute their planned route to minimize drive time which is often unproductive and represents an aggregate burden on society. Such "sig-alerts" disadvantageously require real-time receptions by the drivers prior to entering the congested traffic area. Such "sig-alerts" are often missed when drivers are not tuned into the transmitting station at the proper time. Moreover, drivers tend to learn and routinely follow the same route day after day without becoming familiar with alternate routes even in the face of heavy recurring congestion. Road side signs have also long been used to warn drivers and redirect traffic during road construction or traffic congestion. For example, posted detour signs and electronic road-side billboards have been used to suggest or require alternative routes. Some electronic billboards have been posted on main traffic arteries, warning of pending traffic blockage or congestion. However, these signs and billboards also suffer from being posted too near to the point of congestion or blockage preventing meaningful re-evaluation of the planned route and alteration of that route, primarily because of the required close proximal relationship between the sign location and the point of congestion or blockage. There exists a continuing need to improve the reception of accurate traffic congestion and alternative route information.

Brief Summary Text (5):

Local area radio and TV stations have broadcasted predicted pollution levels, that is, "smog alerts" with a view of altering driver use, such as increased car pooling or collective rapid transit use on days of expected high pollution levels, to minimize and reduce those levels. "Smog alerts" suffer from the same disadvantages as "sig-alerts" in that drivers may not be informed in time to take alternative actions. Moreover, the independent nature of human beings and their respective differing destinations tend to defeat an appropriate communal response to such "smog alerts". There also exists a need to continually reduce automobile travel time and the resulting environmental pollutants by optimizing the travel time or travel distance of vehicles between departure locations and arrival destinations.

Brief Summary Text (6):
Governmental agencies have provided emergency care services in response to road side vehicular accidents, as is well known. Governmental agencies have adopted the well known "911" emergency call method through which road accidents are reported and followed by the dispatching of emergency care services including police, fire and paramedic services using dedicated emergency RF radio systems. Such RF radio systems and methods often require the reporting of the accident by private citizens who are typically either witnesses to the accident or are involved in the accident. However, such systems and methods fail when such victims are incapacitated by injury, or when such witnesses are unable to quickly locate an operating phone especially in remote areas. Moreover, critical time is often lost when searching for a telephone to place the "911" call on a remote telephone. Further still, misinformation may be inadvertently given by those reporting victims and witnesses unfamiliar with the location of the accident thereby directing the emergency care provider to the wrong location. There exists a continuing need to more expeditiously provide accurate vehicular traffic accident information to emergency care providers.

Brief Summary Text (8):
Automobiles have also been adapted with experimental local area digitized road map systems which display a map portion of interest. The driver can locate departure and destination points on the map, and then visually follow the displayed map respecting the current position of the vehicle, as the driver travels toward the desired destination point. The map systems display a cursor to locate the current position of the moving vehicle on the displayed map. The portion of the map that is displayed is periodically adjusted to keep the current position cursor in the center of the displayed map portion. The map systems use a compass and a wheel sensor odometer to move the current position from one location to another as the vehicle travels on the road. The use of such map display systems requires the driver to repetitively study the map and then mentally and repetitively determine and select travel routes diverting attention away from the safe operation of the vehicle. The display of the digitized map with a current position cursor tends to increase traffic accidents, rather than promote safe operation. Also, the compass and wheel odometer technology causes map position error drifts over distance, requiring recalibration after traveling only a few miles. Moreover, the use of such map systems disadvantageously requires the entry of the departure point each time the driver begins a new route.

Brief Summary Text (9):
Additionally, the digitized map systems do not perform route guidance indicating a route through which the driver should take to reach a particular destination point. The digitized map systems are not dynamically updated with current traffic information, such as detours for road construction, blocked routes due to accidents, and delayed travel times due to heavy traffic congestion. Furthermore, such map systems do not provide route guidance based upon varying requirements, such as, least route time, least travel distance, cost-effective least traffic stops and turns, nor a combination thereof, nor based upon dynamic updated current traffic conditions. There exists a continuing need to improve digitized map systems with a driver friendly interface which reduces diversion away from the safe attentive operation of the vehicle to promote accident free dynamic route guidance vehicular operation.

Brief Summary Text (10):
While the aforementioned "sig-alerts", "smog-alerts", "911", detour signs, electronic billboard and digitized map systems and methods have had some success, there exists a wide range of technologies that have disadvantageously not been applied in a comprehensive integrated manner to significantly improve route guidance, reduce

pollution, improve vehicular control and increase safety associated with the common automobile experience. For example, it is known that gyro based inertial navigation systems have been used to generate three-dimensional position information, including exceedingly accurate acceleration and velocity information over a relatively short travel distance, and that GPS satellite positioning systems can provide three-dimensional vehicular positioning and epoch timing, with the inertial system being activated when satellite antenna reception is blocked during "drop out" for continuous precise positioning. It is also known that digitized terrain maps can be electronically correlated to current vehicular transient positions, as have been applied to military styled transports and weapons. For another example, it is also known that digitally encoded information is well suited to RF radio transmission within specific transmission carrier bands, and that automobiles have been adapted to received AM radio, FM radio, and cellular telecommunication RF transmissions. For yet another example, it is further known that automobile electronic processing has been adapted to automatically control braking, steering, suspension and engine operation, for example, anti-lock braking, four-wheel directional steering,. dynamic suspension stiffening during turns and high speed, engine governors limiting vehicular speed, and cruise control for maintaining a desired velocity. For still another example, traffic monitors, such as road embedded magnetic traffic light sensor loops and road surface traffic flow meters have been used to detect traffic flow conditions. While these sensors, meters, elements, systems and controls have served limited specific purposes, the prior art has disadvantageously failed to integrate them in a comprehensive fashion to provide a complete dynamic route guidance, dynamic vehicular control, and safety improvement system.

Brief Summary Text (11):
Recently, certain experimental integrated vehicular dynamic guidance systems have been proposed. Motorola has disclosed an Intelligent Vehicle Highway System in block diagram form in copyright dated 1993 brochure. Delco Electronics has disclosed another Intelligent Vehicle Highway System also in block diagram form in Automotive News published on Apr. 12, 1993. These systems use compass technology for vehicular positioning. However, displacement wheel sensors are plagued by tire slippage, tire wear and are relatively inaccurate requiring recalibration of the current position. Compasses are inexpensive, but suffer from drifting particularly when driving on a straight road for extended periods. Compasses can sense turns, and the system may then be automatically recalibrated to the current position based upon sensing a turn and correlating that turn to the nearest turn on a digitized map, but such recalibration is still prone to errors during excessive drifts. Moreover, digitized map systems with the compass and wheel sensor positioning methods operate in two dimensions on a three-dimensional road terrain injecting further errors between the digitized map position and the current vehicular position due to a failure to sense distance traveled in the vertical dimension.

Brief Summary Text (12):
These Intelligent Vehicle Highway Systems appear to use GPS satellite reception to enhance vehicular tracking on digitized road maps as part of a guidance and control system. These systems use GPS to determine when drift errors become excessive and to indicate that recalibration is necessary. However, the GPS reception is not used for automatic accurate recalibration of current vehicular positioning, even though C-MIGITS and like devices have been used for GPS positioning, inertial sensing and epoch time monitoring, which can provide accurate continuous positioning.

Brief Summary Text (13):
These Intelligent Vehicle Highway Systems use the compass and wheel sensors for vehicular positioning for route guidance, but do not use accurate GPS and inertial route navigation and guidance and do not use inertial measuring units for dynamic vehicular control. Even though dynamic electronic vehicular control, for example, anti-lock braking, anti-skid steering, and electronic control suspension have been contemplated by others, these systems do not appear to functionally integrate these dynamic controls with an accurate inertial route guidance system having an inertial measuring unit well suited for dynamic motion sensing. There exists a need to further integrate and improve these guidance systems with dynamic vehicular control and with improved navigation in a more comprehensive system.

Brief Summary Text (14):

These Intelligent Vehicle Highway Systems also use RF receivers to receive dynamic road condition information for dynamic route guidance, and contemplate infrastructure traffic monitoring, for example, a network for road magnetic sensing loops, and contemplate the RF broadcasting of dynamic traffic conditions for dynamic route guidance. The disclosed two-way RF communication through the use of a transceiver suggests a dedicated two-way RF radio data system. While two-way RF communication is possible, the flow of necessary information between the vehicles and central system appears to be exceedingly lopsided. The flow of information from the vehicles to a central traffic radio data control system may be far less than the required information from traffic radio data control system to the vehicles. It seems that the amount of broadcasted dynamic traffic flow information to the vehicles would be far greater than the information transmitted from the vehicles to the central traffic control center. For example, road side incident or accident emergency messages to a central system may occur far less than the occurrences of congested traffic points on a digitized map having a large number of road coordinate points.

Brief Summary Text (15):
Conserving bandwidth capacity is an objective of RF communication systems. The utilization of existing infrastructure telecommunications would seem cost-effective. AT&T has recently suggested improving the existing cellular communication network with high speed digital cellular communication capabilities. This would enable the use of cellular telecommunications for the purpose of transmitting digital information encoding the location of vehicular incidents and accidents. It then appears that a vehicular radio data system would be cost-effectively used for unidirectional broadcasting of traffic congestion information to the general traveling public, while using existing cellular telecommunication systems for transmitting emergency information. The communication system should be adapted for the expected volume of information. The Intelligent Vehicular Highway Systems disadvantageously suggest a required two-way RF radio data system. The vast amount of information that can be transmitted may tend to expand and completely occupy a dedicated frequency bandwidth. To the extent that any system is bidirectional in operation tends to disadvantageously require additional frequency bandwidth capacity and system complexity. These and other disadvantages are solved and reduced using the present invention.

Drawing Description Text (2):
FIG. 1 is a block diagram of an automobile navigation guidance, control and safety system.

Drawing Description Text (3):
FIG. 2 is an expanded block diagram of the vehicle automobile navigation guidance, control and safety system.

Detailed Description Text (6):
Yet another object of the present invention is to provide a navigation system which accurately positions a vehicle within a local area digitized road map.

Detailed Description Text (8):
Yet another object of the present invention is to provide a vehicular navigation and guidance system which computes optimum routes between departure and destination points.

Detailed Description Text (9):
Still another object of the present invention is to provide a vehicular guidance system which dynamically reroutes travel routes based upon updated and current traffic flow information.

Detailed Description Text (11):
A further object of the present invention is to provide vehicular RF data reception suitable for receiving current traffic flow information.

Detailed Description Text (12):
A further object of the present invention is to provide precise continuous vehicular positioning information using RF satellite and inertial navigation.

Detailed Description Text (14):

Yet a further object of the present invention is to provide precise positioning of vehicles in emergency situations using vehicular inertial and satellite navigation and telecommunications.

Detailed Description Text (15):
Still a further object of the present invention is to provide a comprehensive and integrated vehicular guidance, control and safety system using vehicular inertial and electronic sensing, processing and control in combination with RF communications, RF satellite and inertial navigation, and digitized road maps.

Detailed Description Text (16):
The vehicular navigation system of the present invention integrates an inertial navigation unit and a GPS navigation unit to provide continuous accurate vehicular positioning even during periods of satellite drop out when the reception of GPS navigation signals is blocked by interference. Inertial sensing and navigation in combination with GPS positioning is applied to common transportation vehicles. The GPS RF navigation unit is used to locate the vehicle in three dimensions. The inertial navigation unit is used to modify the current positioning during satellite drop out. Inertial navigation provides vehicular movement information during GPS drop out. GPS and inertial navigation elements combine to provide continuous accurate positioning. Accurate vehicular positioning is combined with the use of digitized road maps for route guidance based upon a variety of routing algorithms, for examples, least time, least distance, least turns or least stops. The improved navigation system reduces problems associated with error drifts over extended traveled distances, and reduces the need for manual recalibration and starting point reentry. The inertial vehicular navigation system is not subject to the same drift errors associated with compass, wheel sensing and GPS positioning, and the resulting need to reenter current positions. GPS monitoring is used to recalibrate vehicular position on a recurring basis.

Detailed Description Text (17):
The inertial navigation unit is also used to sense vehicle instabilities. The present invention includes a vehicular dynamic control system for improved safe operation of the vehicle. Software programmed embedded processors are used to interpret vehicular sensors and inertial information. Advantages of inertial measuring include the computation of accurate instantaneous acceleration and velocity parameters. These parameters are useful in the detection of unstable vehicular conditions. The present invention is enhanced by dynamic superseding automatic control of the vehicle in the case of detected unstable conditions, such as skidding and sliding of the vehicle.

Detailed Description Text (18):
Digitized maps, computer processing and the inertial and GPS navigation units are used to correlate current positions within a local area digitized road map and used for vehicle route guidance to a destination. A radio data system is used to receive up-to-date traffic flow information. The dynamic traffic flow information locates and characterizes the type of traffic flow, including X-Y map coordinates with traffic codes, for examples, road construction, detours, congestion levels, traffic flow rates, hazardous material spills, parking capabilities, weather conditions, among other codes. The digitized maps, computer processing, inertial and GPS navigation systems and the radio data system are used to dynamically reroute the vehicle after departure.

Detailed Description Text (19):
Inertial measuring senses accident or incident conditions. RF Telecommunications is then used to automatically report the accident or incident to emergency road-side service providers. The digitized maps, navigation system with current vehicular position and computer processing are used to automatically initiate and communicate emergency calls with precise location information to the emergency service providers to improve their response time to emergency incidents. These and other advantages will become more apparent from the following detailed description of the preferred embodiment.

Detailed Description Text (21):
Referring to FIG. 1, an automobile navigation guidance, control and safety system of the present invention has various internal processing elements having necessary

processors and programmed memories. A vehicle external system 10 comprises an optical sensor 12 primarily for detecting road obstacles, and one or more antenna 14 for RF reception and transmission. The vehicle external system 10 provides a vehicle information system 16 with optical sensor inputs and RF transmission signal inputs. The vehicle information system 16 includes an RF navigation system 18, an inertial navigation system 20 and a vehicle dynamic position system 22 collectively operating to determine dynamic vehicular positioning. The RF navigation system 18 is a GPS receiver which may be an RI NAVCOR V component in the preferred form. The inertial navigation system 20 is a modified GIC-100 gyro system, in the preferred form, which generates two dimensional acceleration and velocity information. An improved gyro system could be used to provide three-dimensional acceleration and velocity information. The position system 22 is an interface processor for processing signals from the RF navigation system 18 and the inertial navigation system 20, and computes equations for three-dimensional positioning, that is, longitude, latitude and altitude information, and equations for motion for providing two-dimensional acceleration and velocity information.

Detailed Description Text (22):
The vehicle position system 22 transfers three-dimensional current position and time information to a driver information system 24 and also transfers motion information to a vehicular dynamic control system 26. The driver information system 24 provides the computing capability for route guidance planning as adjusted by dynamic traffic flow information received through a radio data system 28.

Detailed Description Text (25):
The vehicle information system 16 also receives information from a driver operating system 38 which is a collection of driver interface systems including a driver steering system 40, a driver throttle system 42 and a driver braking system 44 collectively for monitoring and interacting with driver manipulation of the steering wheel, brake pedal and throttle, not shown. The driver operating system 38 also includes a map storage system 46 for storing digitized road maps, a driver display 48 for displaying map portions surrounding the current position of the vehicle and other information, and an entry device 50 for manual entry of information, for example, a desired destination point, and optional information, for example, a desired cruise control speed.

Detailed Description Text (26):
The display device 48 displays a relevant vicinity map portion of the digitized map. The display device 48 displays the planned route and current position cursor within the displayed vicinity map portion. The planned route and current position cursor would be distinguished by highlighting within the displayed vicinity map. The cursor preferably takes the form of an arrow particularly useful for directional orientation and road side determination, for example, north-bound direction and northbound side of the road. Directional orientation of the current position is also useful to road side emergency care providers attempting to locate and reach an incident on a major thoroughfare.

Detailed Description Text (28):
The map storage system 46 is preferably a CD-ROM reading device reading local area digitized road maps stored on CD-ROM disks having high density storage, though other memory means, such as semi-conductor memory or magnetic memory, may be used. The map storage system 46 may also be a jukebox type mechanism for storage and accessing a plurality of road map memory storage devices. In this manner, a plurality of local area digitized road maps could be used and updated with new maps to keep the desired local area road maps current to new road construction. The digitized maps would include a predetermined level of detail, for example, information would include street blocks, but may not include, for example, individual street addresses. The level of detail of the digitized maps would be within the resolution of the RF satellite and inertial navigation capabilities for accurate correlation between the current position and the digitized map. The combination of the RF satellite and inertial navigation of the present invention takes advantage of any contemplated increased level of the detail of the digitized map.

Detailed Description Text (29):
The driver information system 24 computes dynamic route guidance correlated between

variously received vehicular information including the desired destination point from the entry device 50, digitized map information from the map storage system 46, current position information from the vehicle dynamic position system 22, and, traffic flow information from the radio data system 28. The dynamic route guidance can be based upon a variety of route planning algorithms, such as, least stops, least turns, least distance, and preferably least time, or a complex combination thereof.

Detailed Description Text (32):
Referring to FIG. 2, the driver information system 24 includes an entry controller 68 for receiving information from the entry device 50 and from the map storage system 46. The entry controller 68 is also used to store emergency call information including entered emergency cellular phone numbers. Once the initial vehicular position is entered, it need not be re-entered, as the system of the present invention will thereafter keep track of the current position of the vehicle, but it may be re-entered if the current position data becomes corrupted, for example, by a memory failure, or by an unlikely extended GPS drop out. After initialization of the system, including entry of the initial position, additional information received would then include destination information from the entry device 50 and digitized road map information both of which would be sent to a route planning and area map processor 70 for route guidance. The route planning processor 70 would drive a display driver 72 used to activate and operate the driver display 48. The route planning processor 70 also receives current vehicular position information from a map coordinate translator processor 74 so that the route planning processor 70 can locate the current vehicle position within a digitized map and appropriately display a vicinity map portion with a current vehicle position among other information, including for example, altitude, heading and speed of the vehicle. The route planning processor 70 also receives dynamic traffic flow information from a radio data system message decoder processor 76 for dynamically rerouting previously planned routes based upon current information received from the radio data system 28. The route planning processor 70 receives three types of information including current position and heading from the map coordinate translator processor 74, current dynamic traffic flow information from the radio data system processor 76, and digitized map and destination information from the entry controller 68, to plan vehicular routes. The route planning processor 70 has an output which drives the display driver 72 to control the driver display 48.

Detailed Description Text (33):
The radio data system 28 includes an RF processor 78 for receiving incoming RF transmissions digitally encoded with traffic flow information which may be encoded, for example, with digitized map coordinates and associated current traffic flow indicator information. A pre-set frequency synthesizer 80 is used to provide a local oscillator signal to the RF processor including mixers to demodulate the RF carrier signal containing the radio data system messages which may be transmitted over an AM radio channel or an FM radio channel. The pre-set synthesizer 80 is used to generate a local oscillator signal for isolating the frequency band in which is transmitted the radio data system digitally encoded traffic flow messages. The RF processor 78 is used to select a frequency band of interest and demodulate the carrier to provide a base signal. A demodulator 82 demodulates the base signal into an encoded digital data stream sent to the radio data system message decoder processor 76 which in turns formats the digital data stream into formatted digital messages for the route planning processor 70.

Detailed Description Text (34):
It is contemplated that radio data system messages would cover a predetermined geographic broadcasting area surrounding a particular broadcasting transmitter. The geographic areas are preferably arranged to cover AM/FM broadcasting areas, or alternatively arranged to cover cellular grids similar to cellular telephone operation. Preferably, the radio data system messages should not exist for traffic free-flow map coordinate points to minimize transmitted information and conserve transmission bandwidth capacity. That is, traffic flow radio data system messages would preferably be broadcasted only when there are traffic flow limitations so as to minimize the amount of data transmitted and to optimize the area covered and conserve broadcast bandwidth capacity.

Detailed Description Text (36):
The RF navigation system 18 includes an RF processor 86 for demodulating the GPS

carrier signals, and includes a frequency standard 88 providing a local oscillator. The RF processor 86 provides coded spread GPS signals to a demodulator 90 for despread demodulation to provide an RF navigation processor 92 with digital GPS range information. The RF navigation processor 92 performs three-dimensional positioning and epoch time computation using four, preferably five, GPS satellite signals.

Detailed Description Text (37):
The inertial navigation system 20 includes a dynamic motion sensor 94, preferably a gyro inertial measuring unit, for example, a two-dimensional gyro multi-sensor, or a micro machine device, digital quartz device, or like inertial measuring unit. Two orthogonally mounted multi-sensors form a GIC-100 system which may be used to generate three-dimensional acceleration and velocity measurements. The dynamic motion sensor 94 is controlled by sensor electronics 96 providing necessary power, such as gyro spin supply, and having pick off electronics for sensing acceleration and velocity signals from the dynamic motion sensor 94. The sensor electronics 96 provides the inertial navigation processor 98 with two-dimensional acceleration and velocity signals, but it may be enhanced to provide three-dimensional information as well. A navigation interface processor 84 of the position system 22 receives three-dimensional positioning and epoch time information from the RF processor 92, and receives two-dimensional acceleration and velocity information from the inertial navigation processor 98. The navigation interface processor 84 provides the vehicle dynamic control system 26 with acceleration and velocity data for vehicular control, and provides the map coordinate translator processor 74 with three dimensional positioning data for route guidance, and with epoch time information for emergency calls.

Detailed Description Text (38):
The altitude dimension measurement is inherently less accurate and is less significant than the planar longitude and latitude dimensions in view of the two-dimensional digitized road maps. Preferably, the inertial measuring unit would have one two-axis gyro for horizontal X-Y acceleration and velocity measuring with the GPS RF navigation system being used for altitude measuring, while both the GPS RF navigation unit 18 and the inertial navigation system 20 are used for accurate longitudinal and latitudinal positioning, consistent with two-dimensional digital map information. However, the digitized maps could be enhanced to include altitude information along with traditional horizontal X-Y coordinate information providing a complete three-dimensional topographical terrain digitized map. The inertial navigation system 20 would then preferably have three-dimensional sensing. Two orthogonal gyros each providing two axis measuring, with one axis in each gyro in coincident alignment, would preferably be used in combination with the topographical digitized road map for improved map matching between the digitized map and the computed position for improved smoothing of the tracking of the vehicle on digitized map roads.

Detailed Description Text (39):
Map digitization and navigation positioning will contain errors. When the route processor 70 compares the navigation position with the available road positions on the map, which may be different due to such errors, the route processor 70 will display the cursor to nearest available map road position, thus smoothing the tracking of the vehicle to the digitized map. This map-matching smoothing process adjusts the display output so that the vehicle is displayed exactly on a road, rather than elsewhere based upon the errors of the navigation positioning and digitized map. The driver is unaware of these errors and is provided with an apparently accurate display which, in probability, accurately displays the current position on a road within the digitized map.

Detailed Description Text (40):
The inertial navigation system 20 aids the GPS processor 92 in determining accurate horizontal two-dimensional positioning. The inertial navigation processor 98 with the inertial sensor 94 provides two-dimensional acceleration information, that is, incremental velocity in two dimensions, and two-dimensional velocity information, that is, incremental displacement in two dimensions. The inertial navigation system 20 communicates this information to the navigation interface processors 84 which in turn, provides the GPS RF navigation processor 92 with this acceleration and velocity information. The GPS RF processor 92 also receives GPS signals from the GPS satellites to compute three-dimensional positions and epoch time. The GPS processor 92 uses this computed information with the acceleration and velocity information provided from the

navigation interface processor 84. The GPS RF navigation processor 82 determines accurate two-dimensional information, determines epoch time, and determines less accurate altitude information, and communicates this information to the navigation interface processor 84 which then provides three-dimensional positioning and epoch time information to the driver information system 24. The navigation interface processor 84 also provides two-dimensional acceleration and two-dimensional velocity information to the vehicle dynamic control system 26. C-MIGITS can be used as the RF navigation system 18, the navigation interface processor 84, and the inertial navigation system 20 for inertial sensing, three-dimensional positioning and epoch time monitoring.

Detailed Description Text (41):
During regular operation, the driver would enter destination information through the entry device 50 at the beginning of a trip. That destination information is stored by the entry controller 68 and transferred to the route planning processor 70. The departure position is the current vehicular position at the beginning of a trip known in terms of its three-dimensional position, that is, latitude, longitude and altitude. The route planning processor 70 assimilates both the departure position and the destination position and reads an appropriate vicinity portion of the digitized map from the map storage system 46. The map coordinate translator processor 74 translates the three-dimensional departure position provided by the position system 22 into corresponding map coordinates within the appropriate portion of the digitized map. The map coordinate translator processor 74 also computes a directional compass heading for display and emergency calls use. The map coordinate and compass heading information from map coordinate translator processor 74 is sent to the route planning processor 70. The route planning processor 70 computes and determines a planned route based upon a least time algorithm in the preferred form. As the vehicle moves along or diverges from the planned route, a compass heading computation is made by map coordinate translator processor 74. The reason for the compass computation is that the positioning is not accurate enough to determine which side of the road is being traveled. This compass heading information is useful for driver orientation and for providing precise emergency incident location information.

Detailed Description Text (42):
The compass heading is shown on the display 48 by cursor arrow rotational display. The vehicle cursor position is maintained at the center of a local vicinity displayed portion of the digitized map. The displayed vicinity portion of the digitized map is periodically refreshed and stored in the display driver 72 which controls the corresponding display of the driver display 48 having a current directional cursor at its center representing the present position and direction of the vehicle relative to the displayed vicinity map portion. The route planning processor 70 also receives altitude information from the position system 22. The altitude information may also be displayed. The GPS altitude information is inherently less accurate than the X-Y coordinates, and the altitude need not be displayed.

Detailed Description Text (43):
The route planning processor 70 also receives broadcasted real-time traffic flow and road incident information for the local area through the radio data system 28. This information is preferably encoded for minimum transmission time and is periodically retransmitted with updates as traffic conditions change. The radio data system message decoder processor 76 processes received traffic flow messages and sends the received decoded information to the route planning processor 70 for analysis in route changes and display alerts. Preferably, only traffic flow and road incident information which is pertinent to the driver and the planned route to the destination will be selectively processed by the route planning processor 70 which may display additional information to the driver, in addition to map roads, planned routes and current position. The display 48 may flash warning road blockages, for example, an accident block, or commercial advertising, for example, a motel location, with suitable display designations, for example, like those found along freeway routes. The display 48 may display these designations along a planned route or in close proximity to a planned route. The display could alternatively provide synthesized voice messages of blockages or advertisements as the driver proceeds along the planned route.

Detailed Description Text (44):
The route planning processor 70 will continuously monitor the current position

including any deviations from the planned routes, and continuously monitor traffic and road incident information. During this monitoring, the route planning processor 70 will dynamically reroute the planned route based upon the preferred least time routing algorithm to provide real-time rerouting of planned routes. The least time routes may be based upon speed limits, road distances, road turns, and road stops determined from the digitized road maps. The route planning processor 70 may also alert the driver of the vehicle with, for example, a flashing signal or audible buzzer, or synthesized speech, to indicate to the driver of a new route or route blockage. The display may show the highlighted old route and new updated route. Various color display schemes could be used to enhance driver recognition of the routes. An alternative synthesized voice guidance output, not shown, replacing the display 48, could be used, in which case, the driver may not be made aware that the planned route has been changed when following synthesized voice messages.

Detailed Description Text (46):
If the vehicle exceeds a predetermined longitudinal deceleration or an acceptable roll angle, an accident may be presumed. The inertial navigation system 18 of the present invention would have the processing ability to more accurately detect the difference between real and false accident situations through more accurate modeling of expected accident deceleration profiles. Vehicular air-bags, now common in some vehicles, are activated when certain high acceleration differentials are experienced. Common air-bags contain micro-gyros which sense high deceleration states for activating inflation of the air-bags. Similarly, the 911 preset emergency call would be activated upon sensing excessive deceleration. When the inertial navigation system 20 senses unacceptable deceleration or roll angles, and an emergency incident is presumed, the preferred cellular telephone system 30, or like emergency RF communication capability, is activated to automatically transmit an emergency message to the road-side emergency care providers. An emergency signal is sent to the entry controller 68 and then to the telephone system 30 to inform road-side emergency care providers of an emergency situation. The entry controller 68 is used to store pre-set 911 telephone number. The actual telecommunication path would preferably be a unidirectional digital message sent over an existing cellular telephone network with a dedicated channel and phone number, or over a dedicated RF communication system, so as to communicate accurate map coordinates, epoch time and compass heading in a small amount of time. The emergency message would include the current position coordinate location and compass heading of the vehicle along with epoch time, and other known relevant information. The emergency message may also identify the owner of the vehicle through an entered pre-set code, may contain temperature readings from a temperature sensor, not shown, for fire safety, and may contain actual deceleration and roll angle values. The transmission of an automatic emergency message should increase the response time of the road-side emergency care providers especially when the driver is incapacitated due to injury. The cellular telephone system 30 would be dedicated for emergency use, but may be further integrated with a common cellular transceiver, with an optionally attached standard operating voice cellular handset, both not shown, as are in common use. The communication system 30 may also be activated manually through the entry of a command from the entry device 50, perhaps by simple push button. The entry device may be used to manually initiate an emergency message in the case of other road incidents, for examples, during criminal car-jacking attempts, or during the observation of an accident or road-side incident not involving the subject driver or the subject vehicle.

Detailed Description Text (47):
The present invention includes means for GPS and inertial navigation for dynamic routing processing and dynamic vehicular control integrated with emergency transmission signaling. The present invention may be further modified and enhanced with a variety of additional features. While those skilled in the art may make a variety of modifications and enhancements to the present invention, those modifications and enhancements may nonetheless fall within the spirit and scope of the following claims.

Other Reference Publication (2):
Delco, "Other Vendors Display Navigation Wares at IVHS Event", Inside IVHS, Apr. 26, 1993, p. 6.

CLAIMS:

1. A vehicular guidance, control, and safety system within a vehicle for receiving GPS signals transmitted from GPS satellites, for receiving radio data signals encoded with traffic flow data transmitted from a radio data signal transmitter, the traffic flow data indicating levels of traffic, and for transmitting emergency signals to emergency care receivers, said vehicle having electronic controls connected to vehicular actuators and sensors for controlling the operation of said vehicle, said system comprising:

map storage means for storing digitized road maps having roads digitized as map coordinates,

entry means for entering a destination,

inertial means for sensing acceleration and velocity of said vehicle and providing acceleration and velocity digital signals to indicate that an emergency has occurred,

antenna means for receiving said GPS signals, for receiving said radio data signals, and for transmitting said emergency signals,

GPS receiving means connected to said antenna for demodulating said GPS signals into digital GPS signals,

radio data receiving means for demodulating said radio data signals into digital radio data signals,

emergency transmitter means for transmitting said emergency signals,

processor means connected to said GPS receiving means, said emergency transmitter means, said radio data receiving means, said map storage means, and said entry means, said processor means for computing a current position of said vehicle according to said digital GPS signals and said acceleration and velocity digital signals, and for computing a first route through said digitized map coordinates between said current position and said destination, for computing a second route when said traffic flow data indicates high levels of traffic along said first route, for transmitting said emergency signals encoded with said current position when said acceleration exceeds predetermined deceleration limits, and for dynamically controlling the operation of said vehicle through said vehicular electronic controls, wherein said processor means comprises

inertial processor means for receiving said acceleration and velocity digital signals and for presenting formatted acceleration and velocity digital signals,

GPS processor means for receiving said digital GPS signals, for receiving said acceleration and velocity formatted digital signals, and for computing therefrom a current position of said vehicle,

navigation processor means connected to said inertial processor means and said GPS processor means for communicating said acceleration and velocity formatted digital signals to GPS processor means, and for receiving said current position,

translator processor means connected to said navigation means for receiving said current position and translating the same into current position coordinates,

radio data signal processor means receiving said digital radio data signals and decoding said traffic flow data into traffic flow coordinates,

entry controller processor means for communicating said digitized road maps, for translating said destination into destination coordinates and communicating the same, and for communicating said current position coordinates to said emergency transmitter,

route processor means connected to said translator processor means for receiving said current position coordinates, connected to said entry controller processor means for receiving said digitized road maps and said destination coordinates, connected to said

radio data signal processor means for receiving said traffic flow coordinates, said route processor means for computing a route between said current position coordinates and said destination coordinates within said digitized road maps, and for recomputing a new route between said current position coordinates and said destination coordinates within said digitized road maps but avoiding said traffic flow coordinates, said route processor means also for communicating said current position coordinates to said entry controller processor means for transmitting said emergency signals, and

dynamic control processor means connected to said navigation processor means for receiving said acceleration and velocity formatted digital signals, connected to said vehicular electronic controls for controlling the operation and sensing the condition of said vehicle, said dynamic control processor means for sending control signals to said vehicle's electronic controls in response to unstable conditions determined from said acceleration and velocity formatted digital signals and sensed from said sensors, said dynamic control processor means further connected to said entry controller processor means for initiating the transmission of said emergency signals when said acceleration exceeds predetermined deceleration limits.

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L14: Entry 50 of 56 File: USPT Mar 11, 1997

DOCUMENT-IDENTIFIER: US 5610821 A
TITLE: Optimal and stable route planning system

Brief Summary Text (2):
The present invention relates to vehicle route planning systems, and in particular, to a system for maintaining optimal vehicle traffic flow.

Brief Summary Text (4):
Today, vehicle drivers generally use paper maps, or in some cases electronic maps, to guide them to their destinations. Thus, drivers select their routes based on static data, generally resulting in non-optimal use of the road network under actual conditions. This is because congestion information is not known to drivers and as a result they are not able to navigate so as to avoid the congestion. Anecdotal traffic and road condition information is occasionally available from radio broadcasts, and in rare instances by variable message signs that have been installed in the infrastructure. Such information sources, however, are sparse in the information that they convey and difficult for many drivers to act upon. For example, for a driver unfamiliar with an area, information such as "congestion ahead" from a variable message sign will not provide sufficient information to allow the driver to alter his original route. Non-recurring congestion (e.g., traffic accidents) can cause immense traffic tie-ups and delays. If drivers upstream from these events had adequate information about the congestion and about alternative routes, however, the resulting congestion could be rackreduced. In addition, if a plurality of alternative routes are available and if the drivers could be guided in such a way as to optimally use the alternative routes, then the congestion resulting from an incident, as well as from normal traffic patterns, could be greatly minimized.

Brief Summary Text (5):
U.S. Pat. No. 5,172,321 teaches a method by which dynamic traffic information is communicated to vehicles over a wireless modality so that route selection algorithms in the vehicle can select an optimum route. This is an improvement, but can itself result in unstable traffic flow. Each vehicle receives the same information, and drivers have no knowledge of the route selections of other drivers, allowing the likely possibility of subsequent traffic instability (e.g., traffic jams) if many vehicles choose the same alternate route based on the same information. This system requires a high bandwidth to communicate all dynamic traffic data to all cars in areas with a dense road infrastructure. As a result, to be practical, the system must limit its information broadcast to traffic conditions of the most heavily traveled routes.

Brief Summary Text (6):
As can be seen, a need has arisen for a system for determining optimal traffic flow based upon current and projected traffic and road information, and for communicating that information to vehicles.

Brief Summary Text (8):
The present invention solves the above-identified problems with the prior art by providing a system for determining optimal vehicle routes using current traffic flow information received from individual vehicles.

Drawing Description Text (3):
FIG. 2 is a block diagram of the Traffic Management Center (TMC) depicted in FIG. 1;

Detailed Description Text (2):
FIG. 1 is a block diagram of a preferred embodiment of the present invention. The system includes a plurality of traffic management centers 2 ("TMC") located throughout a region of interest. The TMC's act as local data processing stations for communicating both with vehicles in the area (via a communication service provider), as well as with other sources of traffic information and TMC's, to calculate an optimal routing scheme. The function of the TMC's is to provide traffic congestion modelling, trip planning and route selection for vehicles in the system. This information is conveyed to the vehicles in the form of path vectors, travel advisories, mayday responses and GPS differential correction data.

Detailed Description Text (3):
The TMC's are nodes on a wide area network (e.g., ADVANTIS), with communication capability being provided by, in a preferred embodiment, a fixed data network 4 (e.g., a cellular wireless network) by means of an RF network message switch 5. The network 4 also provides means for TMC communication with a plurality of in-vehicle communication and processing units 6 located in vehicles participating in the system via a wireless data network service provider. The wired and wireless network communication service providers are connected ("bridged") together as is the practice today. The network includes a plurality of base stations 8 located in strategic geographic locations as is common in the existing cellular mobile phone system to ensure broad, uninterrupted coverage of a particular region.

Detailed Description Text (4):
A preferred TMC 2 is shown in FIG. 2. Each TMC comprises a base processing unit 10. In a preferred embodiment, the base processing unit is an IBM RS6000 workstation, but any comparable device can be employed without departing from the spirit or the invention. The processing unit 10 is connected via a wide area network to public safety and emergency service providers, such as local police, fire and ambulance services, as well as to private service sources such as road service providers. The processing unit 10 also receives, via antenna 12, positioned at a known location, Global Positioning System (GPS) signals from GPS satellites, and acts as a differential GPS correction data reference receiver for determining precise locations of vehicles within its geographical area.

Detailed Description Text (9):
FIG. 3 shows a preferred in-vehicle communication and processing unit 20 for use in the system. The unit preferably is an IBM Thinkpad computer, but any comparable computing unit equipped with a communications and location determination interface can be used without departing from the invention. The in-vehicle unit includes a wireless data modem 22 acting as an interface between the unit 20 and the wide area network antenna 33. A GPS receiver 24 is provided for generating vehicle position data, which, when combined with GPS differential correction data of the local TMC, will yield precise vehicle position. The GPS receiver 24 is linked with the in-vehicle unit via PCMCIA slot 26, but any other data interface would not depart from the scope of the invention. It is, therefore, the function of the in-vehicle units to provide the TMCs with trip planning, location and route guidance information. This information is in the form of destinations and travel preferences, actual link travel times and intersection delay queues; and also mayday requests.

Detailed Description Text (10):
It should be understood by those skilled in the art that alternative position sensing means can be employed without departing from the scope of the invention. For instance, the following are acceptable positioning systems: solid-state gyroscope for inertial dead reckoning; solid-state gyroscope and odometer for inertial dead reckoning; wheel encoder and flux gate compass for dead reckoning; GPS or differential GPS augmented by any dead reckoning method.

Detailed Description Text (11):
The in-vehicle unit is augmented with a keyboard 30 to allow the operator to give simple commands to the computer while driving, such as: repeat last instruction; repeat remaining instructions; give current location; and next navigation way point.

Detailed Description Text (12):
In an alternative embodiment, vehicles can be supplied with low-end personal computers

(e.g., notebook computers or palm-top computers) running a simple DOS operating system. In addition, a cost reduced version could be implemented that does not have a general purpose computer at all, but rather an "application-specific" electronic "Navigation Computer". This computer or application-specific unit would connect to or have integrated therewith an antenna for the wireless data communication means, and possibly in addition an antenna or other sensor connections for the position/location subsystem.

Detailed Description Text (13):
A speaker and microphone system 28 are provided to allow interaction between the driver and in-vehicle unit. The unit can be provided with speech recognition and synthesis capability to allow the driver to communicate a desired destination, route, speed, etc., and in turn receive synthesized instructions for reaching the destination. Other driver interfaces are possible and would not depart from the scope of the invention.

Detailed Description Text (14):
The optimal and stable route planning system of the present invention works as follows. Before proceeding with a trip, the driver, using his mobile computer, interacts with the TMC 2 over the wireless system to identify a destination. The starting location is communicated to the TMC from the vehicle position subsystem. Subsequently, the TMC computes a "best" route based on the driver's criteria (e.g., "shortest time") and the TMC's awareness of the routes selected by other travelers, and then sends to the in-vehicle computer a list of road segments and their expected characteristics (e.g., time to transit) that the in-vehicle computer can use to assist the driver in navigating.

Detailed Description Text (15):
The driver begins the trip, following detailed navigation instructions "spoken" by the mobile computer. Instructions may be spoken as taught in U.S. Pat. No. 5,177,685 "Automobile navigation system using real time spoken driving instructions," incorporated herein by reference. The frequency of the instructions can be presented to the driver in descending logarithmic distance to each waypoint, for example:

Detailed Description Text (25):
The driver can select the logarithmic spacing of the navigation instructions to suit personal preferences.

Detailed Description Text (27):
The TMC 2 is programmed to sense significant changes in the transit time of a road segment, due perhaps to a non-recurring incident. This program is able to filter out "outlier" events due to vehicles stopping for random events that do not impact traffic flow (e.g., pulling over to the side of the road to pickup or discharge passengers or cargo).

Detailed Description Text (28):
When the TMC detects a significant change in a road segment's traffic parameters, it searches its list of travel plans to see if any en route vehicles would be affected, and if so, it computes new travel plans for those vehicles. If the new travel plans result in significantly better performance based on the driver's criteria, the new plan and an explanation for the change will be sent over the wireless means to the vehicle's mobile computer. The travel advisory explanation can also be enunciated to the driver using the synthesis means, along with the new travel plan and specific navigation directions.

Detailed Description Text (31):
When a TMC is computing a route for a client vehicle in its territory, and the destination (or any part of the route) is outside the territory, the optimum path algorithm will request over the wide area network dynamic data for specific road segments from the TMC that owns the territory in which the road segment resides. Furthermore, when a route is selected, the TMCs owning the selected road segment will be notified of the expected time that the vehicle will be occupying the specific road segments, so that a properly timed "token" can be instantiated in the database record to allow for the expected occupancy of the vehicle at an approximate time.

Detailed Description Text (35):
The algorithmic task of route selection for a large number of drivers is fairly complex, if one wishes to achieve global optimization of a system involving many drivers. Moreover, the optimization may be difficult to achieve if a large number of drivers choose not to follow the routing instructions provided by the TMC. For this reason, a route selection process which results in a very complex path involving many turning movements may be unattractive to drivers, particularly if it does not ultimately result in very superior performance. Another factor pointing to the desirability of selecting relatively "smooth" route choices is the possible desire of drivers to confine their choice of routes to a few relatively known alternatives. For these reasons, a possible choice of implementation of the invention involves offering drivers an indication of the best of several pre-designed route choices from a given origin to a given destination. A variant of this alternative, applicable to arbitrary origins and destinations, is to offer drivers the best of a few alternate routes between key "nodes" in a network, plus an optimum route from the driver's origin to a starting node, and from a terminal node to the driver's destination.

Detailed Description Text (36):
Many methods for computing optimal shortest time (or shortest distance) routes between two locations on a map are known in the art. One of the earliest, known as the "Djikstra" algorithm, begins with one of the locations and expands from that point perimeters of "iso-time". That is, it takes exactly the same time to get to any location on the iso-time perimeter. The perimeter is continuously expanded one road segment at a time, until an iso-perimeter intersects the destination. Finally, the route to the destination is computed by "backtracking" from the last iso-time perimeter (which represents the total travel time) to the first iso-time perimeter (which represents the first route segment). An iso-time configuration is shown in FIG. 5.

Detailed Description Text (37):
FIGS. 6 and 7 show how the Djikstra algorithm works in the presence of blocked streets. The X's in the grid indicate streets that are closed. Like numerals indicate a like iso-time perimeter, i.e., the same amount of time to reach that destination from the origin O. As shown in FIG. 6, various ones of the streets could also be slower or faster, accumulating more or less time to transit. In the invention, the queue delay at intersections will be accumulated as well, considering the different delays for left turns, right turns and no turns.

Detailed Description Text (38):
FIG. 7 shows how the Djikstra algorithm works in the presence of one-way streets. FIG. 7 indicates that there are two alternative routes from the given origin to the destination. Based on the actual congestion on the individual links, resulting in longer link travel times, one of the routes may be significantly shorter. If the TMC has already assigned routes to vehicles on one of the routes, the resulting marginal expected congestion caused by these vehicles occupying the links may cause the next routed vehicle to be assigned the alternate route (as the best available route).

CLAIMS:

3. The system of claim 1, wherein the data supplied by the in-vehicle comprises units desired route characteristics and destination.

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L14: Entry 37 of 56 File: USPT Nov 13, 2001

DOCUMENT-IDENTIFIER: US 6317684 B1
TITLE: Method and apparatus for navigation using a portable communication device

Abstract Text (1):
The invention provides an apparatus and method for route planning and navigation using a portable communication device. A route planning and navigation unit receives a route request from a caller. The route planning and navigation unit checks the latest traffic/road condition data, long term map database, knowledge database, Internet resources, if necessary, and then determines the best route for the driver to reach the destination. The caller may also enter general destination information and be prompted to may a selection from the possible choices. The route planning and navigation unit may also provide exact location information to police officers and emergency personnel, if necessary. During the navigation phase, the caller may receive turn-by-turn navigation and reminders to change lanes in preparation for turns, etc. The route planning and navigation unit may monitor the caller's location, speed, and direction, and provide the caller with updates based on new traffic or road condition changes affecting the caller's route.

Brief Summary Text (3):
The present invention is directed to a method and apparatus for route planning and navigation using a portable communication device.

Brief Summary Text (5):
There are many navigation products on the market today. Some products provide map data via software stored on CDs for display to the driver while others combine the map data with a GPS receiver connected to a separate computer which can determine and display the current location of the vehicle on a map display.

Brief Summary Text (6):
In such a system, the driver inserts the CD with the stored map software into a portable or vehicle mounted computer. The driver inputs a destination and the computer determines the current location using the GPS receiver. The driver can make a route plan based on the map database. Visual and audio output for driving directions may also be provided.

Brief Summary Text (7):
However, in these navigation systems, an extra computer is needed which requires high power consumption. In addition, the driver often must turn off and turn on the computer to resume navigation to conserve batteries. Furthermore, the CDs with the map data stored therein, cannot accommodate for ever changing road conditions, traffic jams, bad weather, etc. Moreover, such a video display is difficult to mount and may cause a safety hazard if the driver averts his or her eyes to view the screen while driving.

Brief Summary Text (9):
The invention provides an apparatus and method for route planning and navigation using a portable communication device. A route planning and navigation unit receives a route request from a caller. The route planning and navigation unit checks the latest traffic/road condition data, long term map database, knowledge database, Internet resources, if necessary, and then determines the best route for the driver to reach the destination. The best route refers to the route which meets caller's criteria best. For example, the quickest route, the shortest route, the most scenic route, etc.

There may be default criteria set by the route planning and navigation unit or by caller. The caller may specify other constraints also, like intermediate stops.

Brief Summary Text (10):
The caller will be informed about the route plan instantly via voice communication. If the destination is invalid, the caller will be prompt to re-enter. The caller may also enter less detailed address. For example, the caller may say "school within 5 miles to the south". In this instance, the route planning and navigation unit may search and present the caller with all the of the schools in the specified area for the caller to select. Other possible examples of a caller's input that may be handled by the route planning and navigation unit may be when the caller says "Sears' Tower in downtown Chicago" or "the best restaurant nearby". If there is no direct route available to the destination, the caller will be informed and options may be provided, such as a re-entry in case of error, or the closest possible point by road, water (if in a boat), etc., if there is no direct path by vehicle or other form of transportation to the destination.

Brief Summary Text (11):
The route planning and navigation unit may also provide assistance for road, police or medical emergencies. Upon the callers DTMF input or audible request, an emergency signal may be sent to the an emergency 911 operator. The route planning and navigation unit may then support the 911 request by providing exact location information of the caller and other route navigation data for police officers, and other emergency personnel.

Brief Summary Text (12):
With respect to the planned route, if the caller desires, the whole route plan may be read for the caller to remember and follow. If the caller is not fully satisfied with the plan, the route planning and navigation unit will generate a new one either automatically, or based on the caller's inputs. If the caller prefers, the route planning and navigation unit will provide turn-by-turn navigation just when the caller is close to the turn. The route planning and navigation unit may remind the caller to change lanes to prepare for the turn. During the caller's planned trip, if the caller desires, the route planning and navigation unit will provide entertainment or information about a nearby area.

Brief Summary Text (13):
The turn-by-turn navigation may be an interactive voice route navigation which works on either continuous mode or intermittent mode. For continuous mode, the caller's communication device may be on a continuous "talk" mode. The "talk" mode may be one-way or two-way, and may be configured so that, if the caller prefers, the caller may make or receive phone calls while still being connected to the route planing and navigation unit.

Brief Summary Text (14):
There may also be an intermittent mode navigation mode. In this mode, the caller's communication device is switched to a "standby" mode when the caller is not talking with the route planning and navigation unit. The route planning and navigation unit may prompt the caller by placing a call to the caller when a navigation instruction is necessary.

Brief Summary Text (15):
For the navigation modes, the route planning and navigation unit will monitor the caller's location, speed, and direction. If it finds that the caller is close to a turn, it may give the turn-by-turn navigation instructions. If new traffic or road condition changes affect the caller's route or if the caller fails to follow the turn-by-turn instruction, it will re-plan a new route and send navigation instructions to the caller when the caller is close to the next turn. If the route is changed by the route planning and navigation unit, an explanation and the reasons for the change may be provided automatically, or at caller's request.

Brief Summary Text (16):
Anytime during the trip, the caller may contact the route planning and navigation unit for navigation assistance. The route planning and navigation unit will retrieve the caller's route from a storage device and provide turn-by-turn navigation upon request.

Drawing Description Text (4):
FIG. 2 is an exemplary block diagram of the route planning and navigation system;

Drawing Description Text (5):
FIG. 3 is an exemplary block diagram of the route planning and navigation unit of FIG. 2;

Drawing Description Text (6):
FIG. 4 is an exemplary flowchart of the route planning and navigation phases according to one possible embodiment of the invention;

Drawing Description Text (8):
FIG. 6 is an exemplary flowchart of the navigation phase according to another possible embodiment of the invention; and

Detailed Description Text (2):
FIG. 1 is an exemplary overview of the route planning and navigation system. The route planning and navigation service provided by the route planning and navigation service would help callers arrive at a destination by providing, for example, turn-by-turn directions to a destination through the use of a portable communication device. In a route planning phase, the route planning and navigation system would receive a destination address from a caller and any possible intermediate points or waypoints (or any other preference, like a road along a river), plan the route based on a dynamic map database, and output the planned route to the caller for approval. If the caller accepts the route, the caller then may then receive directions from the route planning and navigation system while enroute to the destination.

Detailed Description Text (3):
As shown in FIG. 1, one embodiment of the invention uses, for example, the driver's portable communication device 110 to communicate with a cellular phone relay center 130. The communication device 110 has a built-in GPS receiver to determine the caller's location. According to GPS receivers currently available, operation of the GPS receiver requires the use of a plurality of GPS satellites 120 to calculate its location. The route planning and navigation unit upon receipt of this positional information, would then output audible directions to the caller through the portable communication device 110 until the caller reaches the desired destination.

Detailed Description Text (4):
Throughout the caller's route, the route planning and navigation unit may receive updated road condition and traffic information which may be relayed to the caller, whereby the caller may opt to have the route planning and navigation unit provide an alternative route to avoid any traffic problems, weather, etc. The route planning and navigation unit may then re-plan the route based on the new traffic and road condition and the new navigation instructions will be sent to the caller, accordingly. This process may be completely transparent to the caller if performed automatically, so that the caller does not know whether the route is the original route or one that has been newly planned.

Detailed Description Text (5):
FIG. 2 is an exemplary block diagram of a route planning and navigation system 200 according to the present invention. As shown in FIG. 2, the route planning and navigation system 200 includes terminals 240, 250 and 260 coupled to a network 220. The route planning and navigation system 200 further includes a route planning and navigation unit 210 which includes database 230. The route planning and navigation unit 210 receives signals from satellite 270, a cellular phone relay center 280, for example, or other navigation aids or equipment.

Detailed Description Text (6):
The terminals 240, 250 and 260 may be any portable communication device, such as portable digital assistant (PDA), a laptop or a portable computer, a cellular telephone, a pager or any other device that can send and receive communication signals. The terminals 240, 250 and 260 are assigned an identifier which may include, for example, a mobile identification number (MIN), telephone number, device address,

user account with time stamp, or any other type of numeric or alphanumeric device identifier appropriate for the device. The identifier may also include fixed or programmable serial numbers or fixed or programmable ID numbers. While the terminals 240, 250 and 260 may be one of the portable communication devices listed above, for purposes of explanation, we will assume that terminals 240, 250 and 260 are cellular telephones which includes a GPS receiver.

Detailed Description Text (7):
Communication signals from the terminals 240, 250 and 260 are received by network 220 and are routed through the network 220, by way of routers and switches (not shown) to the route planning and navigation unit 210. The routing may be performed by switches such as Lucent Technologies, Inc. 5ESS and 4ESS switches, for example, which are generally known in the art.

Detailed Description Text (9):
The route planning and navigation unit 210 may be an independent unit coupled to the network 220 (as shown), or it may be distributed throughout the communications network 220. For example, the route planning and navigation unit 210 may be made part of various central offices or servers employed by the network 220 that are distributed throughout the network 220. Any configuration that permits incoming call access from various terminals 240, 250 and 260 on the network 220 to the route planning and navigation unit 210, may be used without departing from the spirit and scope of the present invention.

Detailed Description Text (10):
The route planning and navigation unit 220 is connected to a database 230. The database 230 may be any memory device internal or external to the route planning and navigation unit 210 without departing from the spirit and scope of the present invention. The database 230 may also store other records, such as billing records, subscriber profiles, etc.

Detailed Description Text (11):
The database 230 may also store destinations and routes used by the caller in the past, such as a route to and from a caller's office, etc. In this instance, the caller's route may be permanently stored under the caller's ID number, etc.

Detailed Description Text (12):
Satellite 270 represents any satellite that may provide positioning and/or other information helpful to navigation to a user. The satellite 270 may be part of a Global Positioning System (GPS), a Low Earth Orbit (LEO) satellite, or an Iridium System Satellite, for example. For purposes of discussion, it will be assumed that the satellite 270 is a GPS satellite, so that the GPS phones representing terminals 240, 250 and 260 may be able to receive signals from multiple satellites through a GPS receiver contained within the GPS phone. The GPS receiver is capable of calculating the longitude, latitude and height at an accuracy of 10 meters.

Detailed Description Text (13):
However, any available positioning technique or system, such as a "network triangulation" technique using a cellular relay center 280, for example, may be used to locate the caller within the spirit and scope of the invention.

Detailed Description Text (14):
The location data transmission to the route planning and navigation unit 210 may be automatic and at a given rate (once per second, for example). The positional data may consist of longitude, latitude, height, etc. and consumes a very small portion of the communication channel bandwidth.

Detailed Description Text (16):
The short-term map data refers to non-permanent changes, or dynamic traffic and road conditions, etc. For example, the dynamic data may include a traffic jam caused by a traffic accident lasted several hours in a highway portion, a road pavement replacement or construction project that results in a road closure for a matter of days or months, etc.

Detailed Description Text (17):

For purposes of discussion, the portable communication devices which are represented by terminals 240, 250 and 260 are transported within an automobile. However, the invention may be adapted to provide route planning and navigation for other modes of transportation, such as boats, trains, aircraft, etc.

Detailed Description Text (18):
The services provided by the route planning and navigation system 200 may be provided free of charge by a cellular telephone or Internet provider, or, for example, be a subscriber service whereby the callers are billed upon using this service or by a monthly fee, for example. Accordingly, the caller's billing records may be stored in database 230, for example.

Detailed Description Text (19):
FIG. 3 is an exemplary block diagram of the route planning and navigation unit 210. The route planning and navigation unit 210 includes a controller 310, a database interface 320, a memory 330, a network interface 340, a voice recognition system 350, a GPS interface 360, a traffic information interface 370, a speech synthesizer 380, and a triangulation interface 390. The above components are coupled together through a control/signal bus 300.

Detailed Description Text (20):
When a call is received by the route planning and navigation unit 210, the controller 310 provides the caller with various options through, for example, either a touch-tone menu or voice recognition via the voice recognition system 350 or a human operator through the network interface 340. The options may include whether the caller would like to plan a route, receive navigation information for an existing route, call for an emergency, etc.

Detailed Description Text (21):
In the route planning phase, the controller 310 receives destination and waypoint inputs from the caller through network interface 340. After receiving all of the inputs, the controller 310 may then contact or retrieve information from a traffic information service, such as the automated traffic information service (ATIS), DOT (Federal and State), police and fire stations, Radio and TV stations, resources on the Internet, etc., through the traffic information interface 370. Such traffic information may include information on traffic congestion, roadwork, detours, iced-over bridges, etc. The controller 310 may automatically alter the route for the caller based on the traffic information received, or may provide the caller with an option to alter the route, for example.

Detailed Description Text (23):
In the navigation phase, the route planning and navigation unit 210 may perform several tasks for the caller, including retrieving and providing directions from a stored route filed under the route ID number, providing directions from a present position to a destination if the driver should become lost, for example, providing a detour around traffic congestion and/or an accident, etc. If the caller requests navigation per a route that has been previously stored in the database 230, the controller 310 receives a call or communication from the caller that previously stored the route via the network interface 340. The controller 310 retrieves the route from the database 230 via the database interface 320 or the memory 330 in accordance with the route ID number which has been provided by the caller. The route ID number may be provided via touch tone or audibly so that it is recognized by the voice recognition system 350, for example. Once the controller 310 retrieves the route, the route is provided to the caller on a, for example, turn-by-turn basis. However, other navigation modes may include, for example, a navigation-by-demand mode where the caller presses a phone key to receive the next turn. The controller 310 will receive traffic information and road condition updates via the traffic information interface 370 and provide the caller with information pertinent to the caller's route via network interface 340. The outputs may be either audible or text, for example.

Detailed Description Text (24):
The caller may be notified regarding information concerning the planned route plan virtually instantaneously via voice communication from the controller 310. If the caller's destination is determined by the controller 310 to be invalid, the controller 310 prompts caller to re-enter the information.

Detailed Description Text (25):
The destination information may also be of a general nature. For example, the caller may also say "school within 5 miles to the south". The controller 310 will search for all schools within 5 miles to the south of the caller's present position. The controller 310 may provide the caller with a list of schools to select via a DTMF menu or audibly, for example. Other examples of general inputs that may be handled by the controller 310 of the route planning and navigation unit 210 may be "Sears' Tower in downtown Chicago" or "the best restaurant nearby".

Detailed Description Text (26):
Furthermore, if there is no direct route available to the destination, the controller 310 will inform the caller and provide the caller with options, such as a re-entry in case of error, or the closest possible point by road, water (if in a boat), etc.(if there is no direct path by vehicle or other form of transportation to the destination).

Detailed Description Text (27):
The controller 310 may also provide assistance for road, police or medical emergencies. Upon the callers DTMF input or audible request, an emergency signal may be sent to the an emergency 911 operator. The controller 310 may then support the 911 request by providing exact location information of the caller and other route navigation data for police officers, and other emergency personnel by positional information passed to the controller 310 through the GPS interface 360 or the triangulation interface 390.

Detailed Description Text (28):
With respect to the planned route, if the caller desires, the controller 310 may recite whole planned route for the caller to remember and follow using the speech synthesizer 380. If the caller is not fully satisfied with the plan, the controller 310 will generate a new route either automatically, or based on the caller's inputs. If the caller prefers, the controller 310 will audibly provide turn-by-turn navigation just when the caller is close to the turn using the speech synthesizer 380. The controller 310 may remind the caller to change lanes to prepare for the turn. During the caller's planned trip, if the caller desires, the controller 310 may provide entertainment or information about a nearby area using the speech synthesizer 380.

Detailed Description Text (29):
The turn-by-turn navigation may be an interactive voice route navigation between the caller and the controller 310 through the network interface 340, which works on either continuous mode or intermittent mode, for example. For continuous mode, the caller's communication device may be on a continuous "talk" mode. The "talk" mode may be one-way or two-way, and may be configured so that, if the caller prefers, the caller may make or receive phone calls while still being connected to the route planing and navigation unit 210.

Detailed Description Text (30):
In the intermittent mode navigation mode, the caller's communication device is switched to a "standby" mode when the caller is not communicating with the controller 310. The controller 310 may prompt the caller by, for example, placing a call to the caller, or sounding an audible tone, etc., when a navigation instruction is necessary or forthcoming.

Detailed Description Text (31):
For the navigation modes, the controller 310 will monitor the caller's location, speed, and direction, through the various interfaces. If the controller 310 discovers that the caller is close to a turn, the controller 310 may give turn-by-turn navigation instructions. If new traffic or road condition changes affect the caller's route or if the caller fails to follow the turn-by-turn instruction, the controller 310 may re-plan a new route and send navigation instructions to the caller via the speech synthesizer 380, when the caller is close to the next turn. If the route is changed by the controller 310, an explanation and the reasons for the change may be provided automatically, or at caller's request.

...iled Description Text (32):

Anytime during the trip, the caller may contact the route planning and navigation unit 210 for navigation assistance. The controller 310 of route planning and navigation unit 210 will retrieve the caller's route from the memory 330, or database 230, and provide turn-by-turn navigation upon request.

Detailed Description Text (33):
FIG. 4 is an exemplary flowchart of one possible embodiment of route planning and navigation performed by the route planning and navigation unit 210. At step 410, the controller 310 receives a routing request form a caller using DTMF codes or voice instructions from the portable communication device 110. The caller may dial into the route planning and navigation unit 210 or may press a preprogrammed button on the portable communication device 110, for example. The controller 310 accepts the caller's request and begins to provide service by starting an interactive session. The controller 310 may interpret the caller's input from voice, key stroke, mouse click, etc.

Detailed Description Text (34):
At step 420, as soon as the caller initiates a routing request, the controller 310 determines the caller's current location data which is sent to the controller 310 by the built-in GPS receiver in the caller's portable communication device 110 and prompts the caller to input the destination address and any desired waypoints. The verifies the input destination address with the map databases, for example, and prompts the caller to reenter if not valid.

Detailed Description Text (35):
At step, 430, the controller 310 checks the latest dynamic traffic and road condition data through traffic information interface 370 and determines how the information will affect the caller's route. Then at step 440, the controller 310 determines the caller's route based on the caller's current location, the destination, the caller's input, and the dynamic traffic and road data.

Detailed Description Text (37):
If the caller accepts the route, at step 470, the controller 310 will guide the caller to the destination by providing turn-by-turn navigation. If the caller does not shut off the communication device completely, the controller 310 will constantly monitor the caller's location, moving speed and direction, as well as the latest traffic and road conditions. If the controller 310 determines that the caller has failed to follow the current planned route, or that the latest traffic and road condition changes affect the caller's planned route, the controller 310 will re-plan the route. Once the caller arrives at the destination, at step 480, the caller will be informed (or the caller will terminate), and the process ends.

Detailed Description Text (38):
FIG. 5 is an exemplary flowchart of the navigation phase of another possible embodiment of the invention. At step 510, controller 310 receives a route request from the caller. At step 520, the controller 310 determines the caller's current position and prompts the caller for inputs and receives destination and waypoint information from the caller.

Detailed Description Text (40):
FIG. 6 is an exemplary flowchart of the navigation phase. In step 610, the controller 310 of the route planning and navigation unit 210 receives a request from a caller to retrieve a stored route. The caller may input the route ID and any personal identification numbers, etc. via audio or touch tone (DTMF), for example. At step 620, the controller 310 retrieves the stored route corresponding to the route ID from the database 230 or memory 330. At step 630, the controller 310 determines the caller's current position from, for example, the GPS information received via the GPS receiver in the driver's portable communication device 240, via the GPS interface 360.

Detailed Description Text (41):
At step 640, the controller 310 provides directions from the caller's position on the route via a turn-by-turn basis or on-demand through the portable communication device 240. At step 650, the controller 310 receives a termination signal from the caller. Alternatively, the controller 310 may also terminate the navigation process upon the caller reaching the destination, but may also provide the caller with options, such as

an option to plan a new route.

Detailed Description Text (42):
FIG. 7 is a flowchart of a route detour or changing process. At step 710, the controller 310 receives a request from the caller to enter a route amendment. The route amendment may be generated by the controller 310 based on existing traffic information or inputs from the caller, or the route may be manually input by the caller, for example. At step 720, the controller 310 determines the caller's current position from GPS data, for example and receives inputs from the caller concerning the route. At step 730, the controller 310 checks the latest traffic and road condition data through the traffic information interface 370.

CLAIMS:

1. A method for navigation using a portable communication device in a communication network, comprising:

receiving a route planning request from a caller;

receiving the caller's current position from the portable communication device;

receiving route data inputs including a route destination from the caller;

checking dynamic traffic and road condition data from a real-time traffic data source;

determining the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs;

outputting the planned route to the caller through the portable communication device while the caller is enroute to the destination; and

prompting the caller to confirm if the planned route is acceptable, and if the caller indicates that the planned route is unacceptable, changing the planned route by one of an automatic change or using the caller's inputted change.

5. The method of claim 1, wherein the caller's current position is determined by using one of a GPS satellite receiver located in the caller's portable communication device or a network triangulation technique.

6. The method of claim 1, wherein the outputting step provides navigation instructions by one of a turn-by-turn basis or at the caller's request.

7. A method for navigation using a portable communication device in a communication network, comprising:

receiving a route planning request from a caller;

receiving the caller's current position from the portable communication device;

receiving route data inputs including a route destination from the caller, wherein the receiving route data inputs step receives the caller's route data inputs via one of DTMF codes or speech recognition;

checking dynamic traffic and road condition data from a real-time traffic data source;

determining the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs; and

outputting the planned route to the caller through the portable communication device while the caller is enroute to the destination.

8. A method for navigation using a portable communication device in a communication network, comprising:

receiving a route planning request from a caller;

receiving the caller's current position from the portable communication device;

receiving route data inputs including a route destination from the caller;

checking dynamic traffic and road condition data from a real-time traffic data source;

determining the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs;

outputting the planned route to the caller through the portable communication device while the caller is enroute to the destination;

prompting the caller to confirm if the planned route is acceptable, and if the caller indicates that the planned route is unacceptable, changing the planned route by one of an automatic change or using the caller's inputted change;

continuously monitoring traffic and road condition data from the real-time traffic data source; and

providing the caller with updated traffic information based on information received from the real-time traffic source.

10. A method for navigation using a portable communication device in a communication network, comprising:

receiving a route planning request from a caller;

receiving the caller's current position from the portable communication device;

receiving route data inputs including a route destination from the caller;

checking dynamic traffic and road condition data from a real-time traffic data source;

determining the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs; and

outputting the planned route to the caller through the portable communication device while the caller is enroute to the destination, wherein the outputting step provides the caller with a warning prior to a planned turn in the route and the warning includes traffic lane information.

11. A method for navigation using a portable communication device in a communication network, comprising:

receiving a route planning request from a caller;

receiving the caller's current position from the portable communication device;

receiving route data inputs including a route destination from the caller;

checking dynamic traffic and road condition data from a real-time traffic data source;

determining the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs;

outputting the planned route to the caller through the portable communication device while the caller is enroute to the destination;

providing a direct link to 911 emergency system; and

providing the caller's positional information to emergency personnel in the 911 emergency system upon the caller's request.

12. An apparatus for navigation using a portable communication device in a communication network, comprising:

a memory for storing map and route date; and

a controller that receives a route planning request from a caller, receives the caller's current position from the portable communication device, receives route data inputs including a route destination from the caller, checks dynamic traffic and road condition data from a real-time traffic data source, determines the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs, and outputs the planned route to the caller through the portable communication device while the caller is enroute to the destination, wherein the controller prompts the caller to confirm if the planned route is acceptable, and if the caller indicates that the planned route is unacceptable, the controller changes the planned route by one of an automatic change or using the caller's inputted change.

18. The apparatus of claim 12, wherein the controller determines the caller's current position using one of a GPS satellite receiver located in the caller's portable communication device or a network triangulation technique.

19. The apparatus of claim 12, wherein the controller outputs navigation instructions by one of a turn-by-turn basis or at the caller's request.

20. An apparatus for navigation using a portable communication device in a communication network, comprising:

a memory for storing map and route date; and

a controller that receives a route planning request from a caller, receives the caller's current position from the portable communication device, receives route data inputs including a route destination from the caller, checks dynamic traffic and road condition data from a real-time traffic data source, determines the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs, and outputs the planned route to the caller through the portable communication device while the caller is enroute to the destination, wherein the controller prompts the caller to confirm if the planned route is acceptable, and if the caller indicates that the planned route is unacceptable, the controller changes the planned route by one of an automatic change or using the caller's inputted change, and wherein the controller continuously monitors traffic and road condition data from the real-time traffic data source, and provides the caller with updated traffic information based on information received from the real-time traffic source.

21. An apparatus for navigation using a portable communication device in a communication network, comprising:

a memory for storing map and route date; and

a controller that receives a route planning request from a caller, receives the caller's current position from the portable communication device, receives route data inputs including a route destination from the caller, checks dynamic traffic and road condition data from a real-time traffic data source, determines the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs, and outputs the planned route to the caller through the portable communication device while the caller is enroute to the destination, and wherein the controller provides the caller with a warning prior to a planned turn in the route and the warning includes traffic lane information.

22. An apparatus for navigation using a portable communication device in a communication network, comprising:

a memory for storing map and route date; and

a controller that receives a route planning request from a caller, receives the caller's current position from the portable communication device, receives route data inputs including a route destination from the caller, checks dynamic traffic and road condition data from a real-time traffic data source, determines the caller's planned route based on the received caller's current position, traffic and road condition data and the caller's route data inputs, and outputs the planned route to the caller through the portable communication device while the caller is enroute to the destination, and wherein the controller provides a direct link to 911 emergency system, and provides the caller's positional information to emergency personnel in the 911 emergency system upon the caller's request.